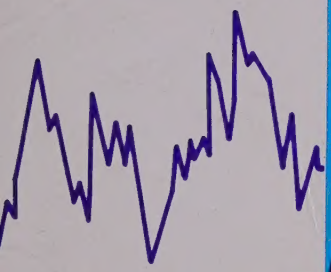
# INSTRUCTION MANUAL

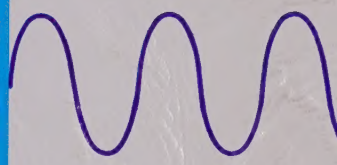
# SD104-10

# SWEEP OSCILLATOR

(PAT. PEND.)

Hank Krieger





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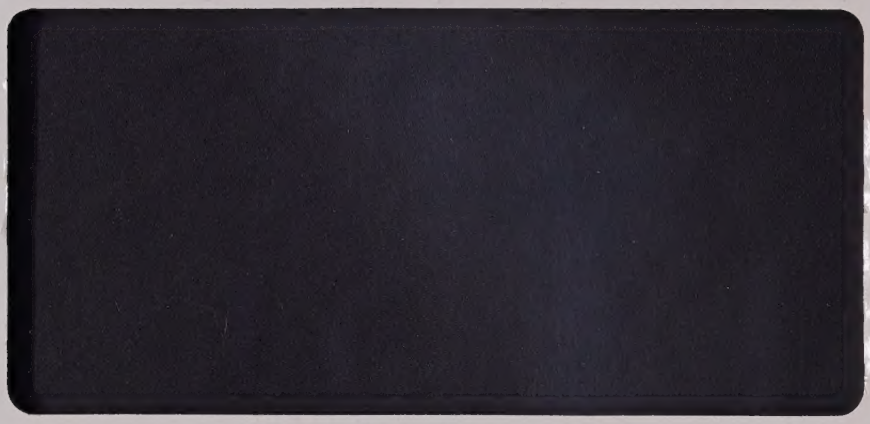

SERIAL 381

# INSTRUCTION MANUAL

# SD104-10

# SWEEP OSCILLATOR

(PAT. PEND.)

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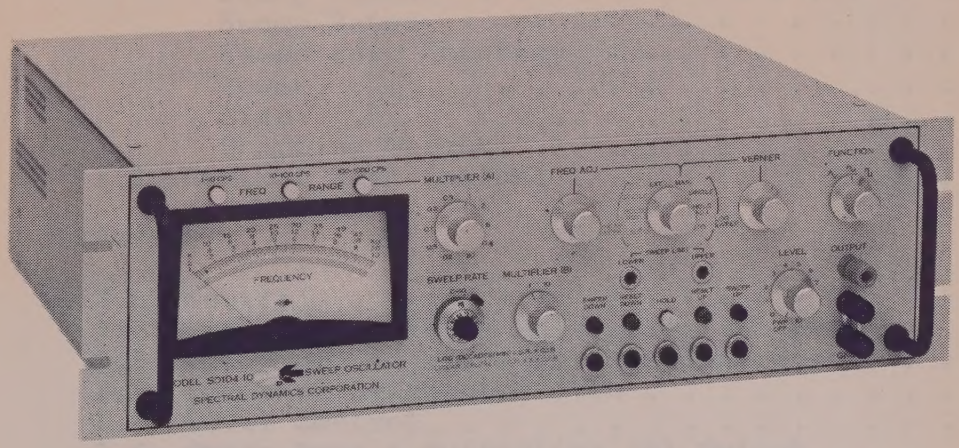


MODEL SD104-10 SWEEP OSCILLATOR

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# SECTION I

# GENERAL INFORMATION

## 1.1 SHIPPING AND INSPECTION PROCEDURE

The Model SD104 Sweep Oscillator is shipped fully assembled in a polystyrene case designed to protect the instrument against all normal shipping hazards. Immediately upon receipt, it is recommended that an inspection be made of the exterior of the shipping case, making note of any visible damage. Retain all forms and invoices attached to the carton and upon removal of the instrument from the case, again note any apparent visible damage.

## 1.2 CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested for functional operational as soon as it is received by following the procedure outlined in Section II. If damage in shipment is apparent, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report forwarded to Spectral Dynamics Corporation. The buyer will be advised of the disposition to be made of the equipment and arrangements shall be made for repair or replacement. Include name, model number and serial number when referring to the instrument for any reason.

## 1.3 WARRANTY

Spectral Dynamics Corporation warrants each instrument manufactured by them to be free from defects in material and workmanship for one year after delivery to the original purchaser. Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory with transportation charges prepaid by the purchaser. This warranty specifically excludes any liability in regard to transistors, fuses and lamps. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate will be submitted to the purchaser prior to commencing repairs.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, including name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

## 1.4 RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via Air Freight to the factory or authorized repair station indicated on the instructions. For shipment, the instrument should be replaced in its original shipping case or in a strong exterior container surrounded by two or three inches of shock absorbing material.

## 1.5 SPECIFICATIONS (Model SD104-10)

This instrument has been carefully calibrated and inspected prior to shipment, according to the following specifications:

Frequency

Range: 0.02 Hz to 20,000 Hz in ten ranges as follows:

| | |
|---|---|
| 0.02 Hz to 20 Hz | 1 Hz to 1,000 Hz |
| 0.05 Hz to 50 Hz | 2 Hz to 2,000 Hz |
| 0.10 Hz to 100 Hz | 5 Hz to 5,000 Hz |
| 0.20 Hz to 200 Hz | 10 Hz to 10,000 Hz |
| 0.50 Hz to 500 Hz | 20 Hz to 20,000 Hz |

Stability: .005% of full range, ± 1% of frequency for a period of 8 hours.

Sweep Limits: An upper and lower frequency limit can be preset electronically from the front panel. The upper frequency limit can be set anywhere in the upper decade of each range. The lower frequency limit can be set anywhere in the lower two decades of each range.

Sweep Accuracy: Upper Limit - 0.5% of reading.
Lower Limit - 0.5% of reading, ±.02% of full range.

Display: Front panel meter with automatic range selection. Any single decade of the 3 decade ranges is displayed automatically in conjunction with indicator lights located above the meter.

Display Accuracy: ± 2% of reading after 1 hour warmup.

Outputs Available at BNC connectors on rear of chassis.
Impedance: 600 ohms or less.

(1) Sine Wave (constant amplitude)
Amplitude: 1 volt rms (approx.)
Response: ± 0.2 db, .005 Hz to 50 kHz
Distortion: Less than 0.5%, .005 Hz to 5 kHz range (Mult.(A) - .02 to 5)
Less than 1%, 40 Hz to 20 kHz in 20 Hz to 20 kHz range;
20 Hz to 10 kHz in 10 Hz to to 10 kHz range.
Less than 1.5%, 20 Hz to 40 Hz in 20 Hz to 20 kHz range;
10 Hz to 20 Hz in 10 Hz to 10 kHz range

(2) Square Wave (constant amplitude)
Amplitude: 5 volts p-p (approx.)
Response: ±0.02 db, .02 Hz to 20 kHz

Outputs (Cont'd)

(3) Triangle Wave (constant amplitude)

| | |
|---|---|
| Amplitude: | 5 volts p-p (approx.) |
| Response: | ±0.25 db, 0.02 Hz to 5 kHz |
| | ±0.50 db, 5 kHz to 20 kHz |

(4) Sine, Square or Triangle Wave (variable amplitude)

| | |
|---|---|
| Selection: | Front panel control |
| Amplitude: | Adjustable over a 50 db range from 10 volts p-p |
| Offset: | Adjustable, ±2.5 volts dc |

(5) Positive dc proportional to log frequency

| | |
|---|---|
| Amplitude: | 1 volt dc full range (approx.) |
| Accuracy: | ±0.25 db after 1 hour warmup |

(6) Positive & negative dc proportional to linear frequency

| | |
|---|---|
| Amplitude: | Plus & minus 10 volts dc full range (approximately) |
| Linearity: | ±0.2% of full range, .02 Hz to 5 kHz |
| Best zero-based straight line: | ±0.4% of full range, 5 kHz to 20 kHz |

(7) Sweep Sync

| | |
|---|---|
| Amplitude: | Positive 3 volts pulse, minimum |
| Pulsewidth: | Approximately 0.5 milliseconds |

The sweep sync pulse is generated at the beginning of each sweep and at each point where direction of sweep changes.

Sweep Modes

(1) Linear or logarithmic sweep rates with single or repetitive sweeps.

(2) External - Can be driven from an external positive signal source for programming. Input impedance is 100k ohms. Positive 10 volts full range sensitivity. May be used in this mode as a dc log converter.

(3) Manual - The coarse and vernier frequency adjustments combine to provide ease of precise frequency setting.

(4) Hold - Provides a short term stop of the sweep at any desired frequency.

(5) Reset - May be reset to either upper or lower limit for starting sweeps. Time of reset is 3 seconds (Approx.)

Sweep Rates

(1) Logarithmic - 0 to 10 decades/minutes, continuously variable.

(2) Linear - 0 to 1000 Hz/seconds, continuously variable. Actual rate depends on frequency rate selected.

Sweep Rate Accuracy (% of setting):

| Sweep Rate Control | Log Mode | Linear Mode |
|---|---|---|
| 1 - 10 | ±3% | ±1% |
| 0.5 - 1.0 | ±5% | ±3% |
| 0.1 - 0.5 | ±10% | ±10% |
| 0 - 0.1 | - - Usable but not calibrated - - | |

Power: 115/230 volts ac, 50/60 cycles at approximately 20 watts.

Note: The SD104 is normally factory wired for 115 volts ac operation. Refer to Figure 30, Interconnecting Diagram, for alternate wiring of power transformer T1 to provide 230 volts ac operation.

Size: 5.25" x 19" x 15" (13,3 x 48,3 x 38,1 centimeters).

Shipping Weight: 25 lbs. (approx.) (11,3 kilograms).

## 1.6 GENERAL DESCRIPTION

The instrument is mounted on a 5-1/4" x 19" standard rack panel, and a chassis that extends 15" behind the front panel. All the modular type printed circuit card assemblies are easily accessible from the top of the chassis with the top cover removed.

With the exception of A10, Relay Switching Assembly 23044-1, each printed circuit card assembly is individually keyed to match a corresponding nylon key insert in a chassis mounted female receptacle. Particular care should be exercised to ensure that assemblies A1 thru A9 and A11 thru A12 are NOT inserted in the space provided for A10 at any time.

Although the printed circuit card plug-in assemblies currently in use number from A1 thru A12, provision has been made for future circuit card design in spaces labelled A13 thru A15. A connector has been installed in A15 as convenience housing for Circuit Card Extension Assembly 23060-1.

Rear chassis BNC connectors J16, J17, J18 and J27 serve no useful purpose in the standard models SD104 Sweep Oscillators. However, available as an optional feature is the "Wide Band Phase Shift Modification", which makes use of these connectors to provide four constant amplitude, fixed phase, sinewave outputs simultaneously (0°, 90°, 180° and 270°). This modification consists of two printed circuit card plug-in assemblies and associated wiring, identified as A14 and A15, and mating receptacles mounted on the top of the chassis.

## SECTION II

## OPERATION

### 2.1 GENERAL

The front panel main function switch is color coded and arranged according to four basic modes of operation; (1)MANUAL, (2)EXTERNAL, (3)LINEAR SWEEP, and (4)LOG SWEEP. All outputs are available at all times in any of the sweep modes. The dc proportional to log frequency is available in all modes including the linear and logarithmic sweep modes.

> Before applying power to the instrument, set the meter mechanical zero adjust screw so that the pointer is resting exactly on 1.

The power on-off switch for the instrument is the extreme counter-clockwise position of the LEVEL control. When this control is rotated clockwise to the first detent position, there will be a time delay of approximately 20 seconds before any indication is noticed on the front panel frequency meter. This is a normal time delay feature designed to protect the instrument against current surges.

### 2.2 FREQUENCY METER & MULTIPLIER (A) SWITCH

The frequency meter, in conjunction with the MULTIPLIER (A) switch and the decade indicator lights located above the meter, provides a reading of the actual frequency being produced by the SD104. To illustrate, assume that the MULTIPLIER (A) switch is in the 1 position. When the decade indicator light to the far left is on, the meter scale covers a range of 1 to 10 Hz. When the middle decade indicator light is on, the meter scale covers a range of 10 to 100 Hz. When the decade indicator light to the far right is on, the meter scale covers a range of 100 to 1000 Hz. This automatic switching action is in the meter circuitry ONLY and in no way affects the internal operation of the instrument or any of its outputs. Hysteresis has been built into the meter switching to facilitate the setting of any frequency at the extremes of the calibrated dial.

Ten multiples of the three basic ranges are obtainable by rotating the MULTIPLIER (A) switch and multiplying the meter reading by the position selected.

Example: The meter indicates 3; the middle decade light is on; MULTIPLIER (A) switch is in the 0.1 position.

The frequency is: 30 x 0.1 = 3.0 Hz

Example: The meter indicates 3; the decade light to the far right is on; MULTIPLIER (A) switch is in the 10 position

The frequency is: 300 x 10 = 3,000 Hz

## 2.3 FREQUENCY ADJUST & VERNIER CONTROLS

The FREQ ADJ and VERNIER controls set the operating frequency of the SD104 when in the MAN. position of the Sweep Mode Selector. The FREQ ADJ control by itself will normally have sufficient resolution. The VERNIER control, with 10 times greater resolution, will be useful in setting the SD104 to a particular frequency.

## 2.4 FUNCTION SELECTOR SWITCH

A FUNCTION selector switch is located in the upper right hand corner of the front panel and its position determines the type of output (triangle, sine or square wave) available at the front panel OUTPUT terminals and at J22, BNC rear chassis connector.

## 2.5 LEVEL CONTROL

The amplitude of the output at the front panel output terminals and at J22, BNC rear chassis connector, is determined by the setting of the LEVEL control, within the range of 30 millivolts to approximately 10 volts peak-to-peak. The extreme counter-clockwise position of the LEVEL control is the on-off power switch for the instrument.

## 2.6 SWEEP RATE AND MULTIPLIER (B) CONTROLS

When sweeping logarithmically as a sweeping oscillator, the sweep speed, in decades/minute, is determined by multiplying the setting of the SWEEP RATE control by the MULTIPLIER (B) switch position, and multiplying the product by the factor of 0.1.

Formula: Log (dec/min) = SWEEP RATE X MULTIPLIER (B) X 0.1

Example To sweep logarithmically at a rate of 0.06 decades/minute, set the SWEEP RATE Control at 0.6 and the MULTIPLIER (B) switch at 1. (The sweep mode switch must be in a LOG SWEEP position).

Solution: 0.6 x 1 x 0.1 - 0.06 dec/min

When sweeping linearly, the sweep speed in Hz/sec is determined by multiplying the setting of the SWEEP RATE control by the MULTIPLIER (A) switch position, multiplying the product by the MULTIPLIER (B) switch setting and that product by the factor of 0.2.

Formula: Lin (Hz/sec) = SWEEP RATE x MULTIPLIER (A)
x MULTIPLIER (B) x 0.2

Example: To sweep linearly at a rate of 4.0 Hz/sec with the MULTIPLIER (A) switch set at 20, set SWEEP RATE control at 1 and MULTIPLIER (B) at 1. (The sweep mode switch must be in a LINEAR SWEEP position).

Solution: 1 x 20 x 1 x 0.2 = 4.0 Hz/sec

## 2.7 SWEEP MODE SWITCH & PUSHBUTTONS

The following is a detailed explanation of the various positions of the Sweep Mode Switch and use of the pushbuttons.

### MANUAL MODE

In the MAN. mode the SD104 acts as a variable frequency oscillator. After setting MULTIPLIER (A) to the desired frequency range, any frequency within that range may be obtained by turning the FREQ ADJ control, utilizing the VERNIER control when necessary for greater resolution. Both the FREQ ADJ and VERNIER will have to be turned fully counter-clockwise to obtain the lowest frequency in any given range.

Example: To obtain 100 Hz in the MAN. mode:

1. Set sweep mode switch to MAN.
2. Set MULTIPLIER (A) to 1 (1 Hz to 1000 Hz)
3. By means of the FREQ ADJ control, obtain a reading of 10 on the frequency meter with the middle decade light on.

### EXTERNAL MODE

In the EXT mode the SD104 acts as a Voltage Controlled Oscillator (VCO) controlled by the dc voltage applied to J29 on the rear of the chassis. This dc voltage should be limited to the range of +10 millivolts to +10 volts. The frequency meter, in conjunction with the setting of the MULTIPLIER (A) switch, will indicate the VCO frequency. All of the SD104 outputs are functioning and in this mode the instrument may be used as a highly accurate dc log converter. The dc output at J24 will be proportional to the log of the applied dc voltage, plus or minus 0.25 db.

### UPPER AND LOWER LIMIT ADJUSTMENTS

When operating the SD104 as a Sweep Oscillator, the upper and lower frequency limits can be set from the front panel. This is accomplished by first setting the mode selector switch to the particular type of sweep desired. To set the lower limit, push the RESET DOWN pushbutton and turn the adjacent screwdriver adjustment until the desired frequency is indicated on the meter. To set the upper limit, push the RESET UP pushbutton and turn the adjacent screwdriver adjustment to the desired frequency as shown on the meter. When switching from LOG SWEEP to LINEAR SWEEP or vice versa, the lower limit must be reset.

### SINGLE SWEEP MODE (LOG OR LINEAR)

In this mode the SD104 will sweep once, either from the lower limit to the upper limit or vice versa.

## 2.7 SWEEP MODE SWITCH & PUSHBUTTONS (Cont'd)

### SINGLE SWEEP MODE (LOG OR LINEAR) (Cont'd)

Example: To sweep once from the lower limit to the upper limit, set the sweep mode switch to SINGLE (log or linear) and push the RESET DOWN pushbutton. It will automatically reset to the preset lower frequency limit. When the lower limit is reached, as indicated by the frequency meter, push the SWEEP UP pushbutton, actuating a single "up" sweep. When the upper limit is reached, the sweep will stop and the RESET UP light will turn on.

Example: To sweep once from the upper limit to the lower limit, set the sweep mode switch to SINGLE (log or linear) and push the RESET UP pushbutton. It will automatically reset to the preset upper limit. When the upper limit is reached, as indicated by the frequency meter, push the SWEEP DOWN pushbutton, actuating a single "down" sweep. When the lower limit is reached, the sweep will stop and the RESET DOWN light will turn on.

### AUTO SWEEP MODE (LOG OR LINEAR)

In this mode the SD104 will sweep repetitively between the upper and lower limits. This repetitive sweeping may be initiated from either the upper or the lower limit in the same manner as in the single sweep mode. A minimum frequency difference between the upper and lower limits of 3% of full range must be maintained. In addition, the lower limit must always be set at a lower frequency than the upper limit, otherwise the relay logic may "lockup".

### HOLD ADJUST MODE (LOG OR LINEAR)

When in the HOLD ADJ mode the SWEEP UP AND SWEEP DOWN pushbuttons may be used like "elevator" controls. The SD104 will sweep up as long as the SWEEP UP button is depressed, and will stop as soon as the pushbutton is released. This action is identical for SWEEP DOWN. To place the SD104 in the hold adjust mode, push the HOLD pushbutton when operating in either single or automatic sweep. Then turn the Sweep Mode Selector to the HOLD ADJ position.

### HOLD FUNCTION

To stop any single or automatic sweep, depress the HOLD pushbutton. The SD104 will remain in HOLD until another button is depressed. A slight amount of drift in this mode is normal.

## 2.8 TYPICAL OPERATION

Assume that a single linear sweep from 0.2 Hz to 12 Hz is desired with a sweep rate of 0.2 Hz/sec. Set MULTIPLIER (A) at .02 (0.02-20 Hz range, MULTIPLIER (B) at 10 and SWEEP RATE control at 5.

By formula, the sweep rate is:

$$\text{Lin (Hz/sec)} = 5.0 \times 10 \times .02 \times .2 = 0.2 \text{ Hz/sec}$$

## 2.8 TYPICAL OPERATION (Cont'd)

Set Sweep Mode Switch to SINGLE LINEAR SWEEP. Depress the RESET UP pushbutton and set UPPER LIMIT for a meter reading of 12 in the highest decade range (Note: This is a direct meter scale reading with reference to the center scale). Depress the RESET DOWN pushbutton and adjust LOWER LIMIT for a reading of 20 in the lowest decade range (20 = .2). Initiate the single "UP" sweep by depressing the SWEEP UP pushbutton. The total time required for the sweep will be:

$$\text{Sweep time} = \frac{\text{frequency difference}}{\text{sweep rate}} \quad \text{or} \quad \frac{12 - .2}{0.2} = 59 \text{ seconds}$$

As stated in the specifications, the SWEEP RATE control is usable from 0 to 0.1, but it is not calibrated over this range. Very slow sweep rates may be obtained in this range using the cut-and-try method. With the control set at 0, the sweep circuit is actually in the HOLD mode as far as frequency sweep is concerned. With practice, an operator can slow the sweep down gently to a complete stop, then continue on as desired.

## 2.9 AUXILIARY FUNCTIONS

Rear panel connector J30 (AUX FUNCTIONS) and toggle switch S12 (SWEEP RATE INT/EXT) as applicable, provide certain additional interconnecting circuitry as described below:

| J30 Pin Designation | Description/Function |
|---|---|
| D | Positive 15 volts dc, regulated. Source impedance 1000 ohms. Short circuit proof. |
| G | Circuit ground. |
| E | Negative 15 volts dc, regulated. Source impedance 1000 ohms. Short circuit proof. |
| J | Input to the Sweep Integrator. Used for external control of sweep rate and direction. Maximum permissable input voltage is positive or negative 10 volts dc. Input impedance is 1.8 megohms in LOG mode, 5 megohms in LINEAR mode. |
| H | Sweep control voltage from internal sweep circuit. Connected internally to Sweep Integrator when S12 is in the INT position. Source impedance 1000 ohms or less. Short circuit proof. Output voltage and polarity depends on front panel sweep speed and direction settings. |
| F | Negative dc-proportional-to-output frequency. |

## 2.9 AUXILIARY FUNCTIONS (Cont'd)

| J30 Pin Designation | Description/Function |
|---|---|
| L | Positive or negative 15 volts dc, regulated, depending on direction of sweep. Negative 15 volts for UP sweep; positive 15 volts for DOWN sweep. May be used for general instrumentation applications. Provides required dc input for Model SD27 Multi-Filter Selector used in conjunction with Spectral Dynamics Tracking Filters and Dynamic Analyzers.<br><br>Current drawn from pin L of J30 must not exceed 50 milliamps. A short circuit will not damage the instrument but will cause it to be inoperative until the short is removed. This circuit connects directly to the positive or negative dc supply. Output impedance is less than 1 ohm. |

The SWEEP rate switch, S12, determines whether the SD104 sweep rate and direction are controlled internally(front panel), or externally via pin J of J30. For all normal operation, this switch should be set in the INT position.

## 2.10 SWEEP RATE CONVERSION

The following table converts the decades-per-minute sweep rate of the Model SD104 Sweep Oscillator to its equivalent in degrees per minute as related to the tuning dial commonly used on Bruel & Kjaer Automatic Vibration Exciter Controllers.

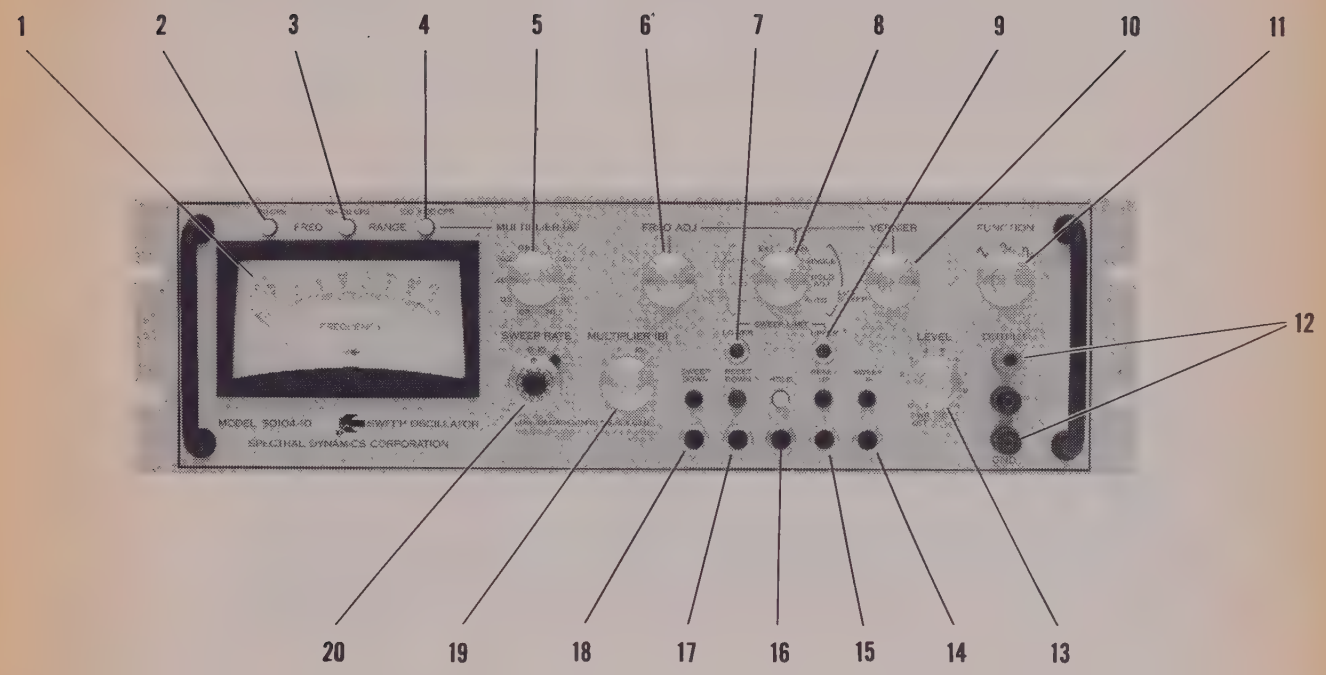
| DECADES PER MIN. | DEGREES PER MIN. |
|---|---|
| .04 | 2.88 |
| .05 | 3.60 |
| .06 | 4.32 |
| .07 | 5.04 |
| .08 | 5.76 |
| .09 | 6.48 |
| .1 | 7.2 |
| .2 | 14.4 |
| .3 | 21.6 |
| .4 | 28.8 |
| .5 | 36.0 |
| .6 | 43.2 |
| .7 | 50.4 |
| .8 | 57.6 |
| .9 | 64.8 |
| 1.0 | 72.0 |
| 2.0 | 144.0 |
| 3.0 | 216.0 |
| 4.0 | 288.0 |
| 5.0 | 360.0 |
| 6.0 | 432.0 |

## 2.10 SWEEP RATE CONVERSION (Cont'd)

In addition, the following formula may be used to convert octaves-per-minute to decades-per-minute:

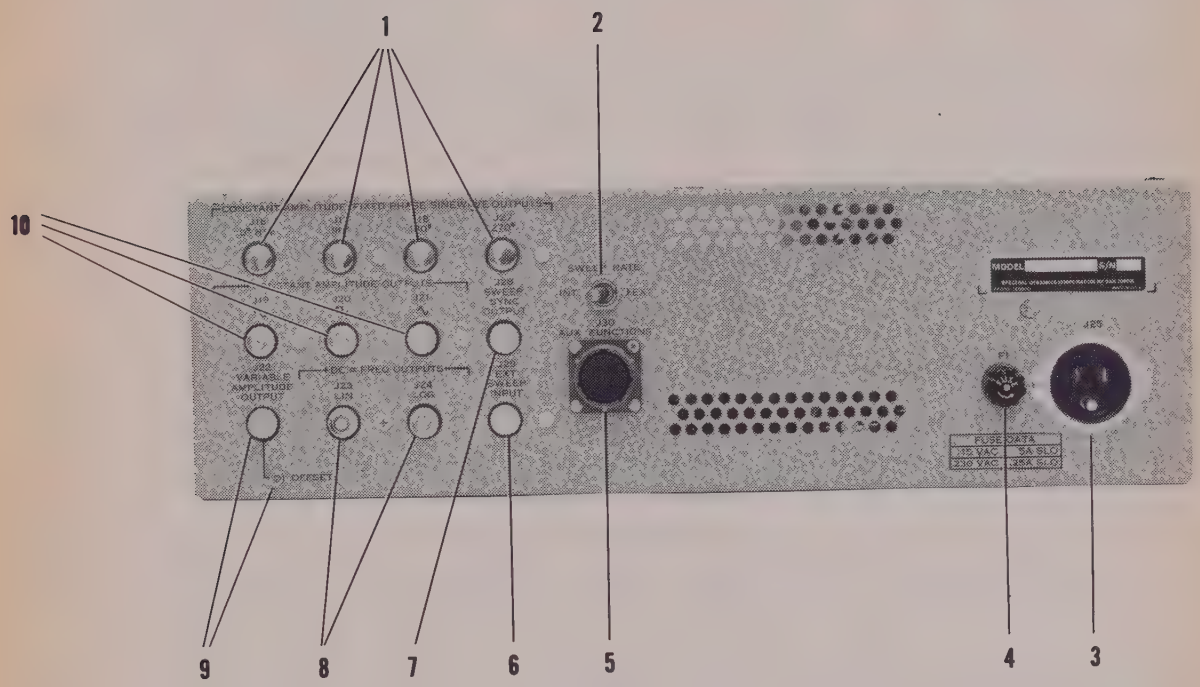
$$\text{Decades/Min.} = \frac{\text{X Octaves/Min.}}{3.32}$$

Where: X = Number of octaves-per-minute




1 FREQUENCY METER (M1)
2 DECADE INDICATOR LIGHT (1 - 10 Hz)
3 DECADE INDICATOR LIGHT (10 - 100 Hz)
4 DECADE INDICATOR LIGHT (100 - 1000 Hz)
5 MULTIPLIER (A) SWITCH (S1)
6 FREQUENCY ADJUST (R36)
7 LOWER LIMIT ADJUST (R29)
8 SWEEP MODE SWITCH (S2)
9 UPPER LIMIT ADJUST (R33)
10 VERNIER ADJUST (R2)
11 FUNCTION SELECTOR (S7)
12 OUTPUT/GND TERMINALS (J26)
13 OUTPUT LEVEL ADJUST/ON-OFF SWITCH (R1/S11)
14 SWEEP UP PUSHBUTTON (S9)
15 RESET UP PUSHBUTTON (S8)
16 HOLD PUSHBUTTON (S5)
17 RESET DOWN PUSHBUTTON (S6)
18 SWEEP DOWN PUSHBUTTON (S10)
19 MULTIPLIER (B) SWITCH (S13)
20 SWEEP RATE CONTROL (R50)

Figure 1. Front Panel View




1 CONSTANT AMPLITUDE, FIXED PHASE SINEWAVE OUTPUTS (OPTIONAL) (J16, J17, J18, J27)

2 INTERNAL-EXTERNAL SWEEP RATE SWITCH (S12)

3 POWER INPUT (J25)

4 FUSE (F1)

5 AUXILIARY FUNCTIONS (J30)

6 EXTERNAL SWEEP INPUT (J29)

7 SWEEP SYNC OUTPUT (J28)

8 POSITIVE DC PROPORTIONAL TO FREQUENCY OUTPUTS - LINEAR & LOG (J23, J24)

9 VARIABLE AMPLITUDE OUTPUT & OFFSET ADJUST (J22, R31)

10 CONSTANT AMPLITUDE OUTPUTS - SINE, SQUARE, TRIANGLE WAVE (J19, J20, J21)

Figure 2. Rear Chassis View

## SECTION III

## THEORY OF OPERATION

### 3.1 INTRODUCTION

The theory of operation for the SD104 Sweep Oscillator can be divided into two basic functions: (1) a precision Voltage Controlled Oscillator (VCO), and (2) a Sweep Generator that drives the VCO. For the following discussion refer to the Simplified Block Diagram, Figure 3, which shows a Model SD104 sweeping in the Automatic Linear Sweep Mode.

### 3.2 SWEEP GENERATOR

Amplifier #1 is an Operational Integrator which produces a ramp voltage. The slope of the ramp it produces is determined by a series resistor selected by the Sweep Rate Switch, and the voltage from MULTIPLIER (B) through K4. To select a fast sweep a low value resistor is chosen by the Sweep Rate Switch, and for a slow sweep a high value resistor is chosen. The voltage supplied by K4 to the Integrator is reduced to 1/10th its original value when MULTIPLIER (B) is in the 0.1 position, thereby providing even slower sweep speeds.

Assuming that K4 is not energized, a negative voltage is supplied to the series resistor selected by the Sweep Rate Switch, causing a positive going ramp at point A. Amplifiers #2 and #3 are Inverter Amplifiers with a gain of 1. The Upper Level Switch is a voltage comparator that generates a pulse when the voltage at point C exceeds the voltage from the Upper Limit Adjust potentiometer. When this occurs, the bistable multivibrator changes state, energizing K4, which in turn supplies a positive voltage to the Integrator, causing the ramp to have a negative going slope and the process repeats itself.

The lower frequency adjust potentiometer voltage is summed into Amplifier #2, creating an offset voltage and determines the lowest voltage (lowest frequency of the VCO) to which the SD104 will sweep.

The negative dc-proportional-to-frequency at point B is available at J30-F and drives the Log Converter. The Log Converter produces a positive voltage that is proportional to the logarithm of the negative dc voltage and is proportional to the logarithm of the frequency produced by the SD104. The log voltage is available at J24. The positive dc-proportional-to-frequency at point C drives the VCO and the meter circuitry and is available at J23.

The Meter Switching Circuit selects the correct meter scale resistance and the corresponding decade indicator light as the positive dc-proportional-to-frequency changes. The decade indicator light to the far left will glow between 10 millivolts and 100 millivolts, the middle decade indicator light will glow between 100 millivolts and 1 volt and the decade indicator light to the far right will glow between 1 volt and 10 volts. The additional set of contacts on relay K4 energizes the SWEEP UP and SWEEP DOWN indicator lights.

## 3.3 VOLTAGE CONTROLLED OSCILLATOR (VCO)

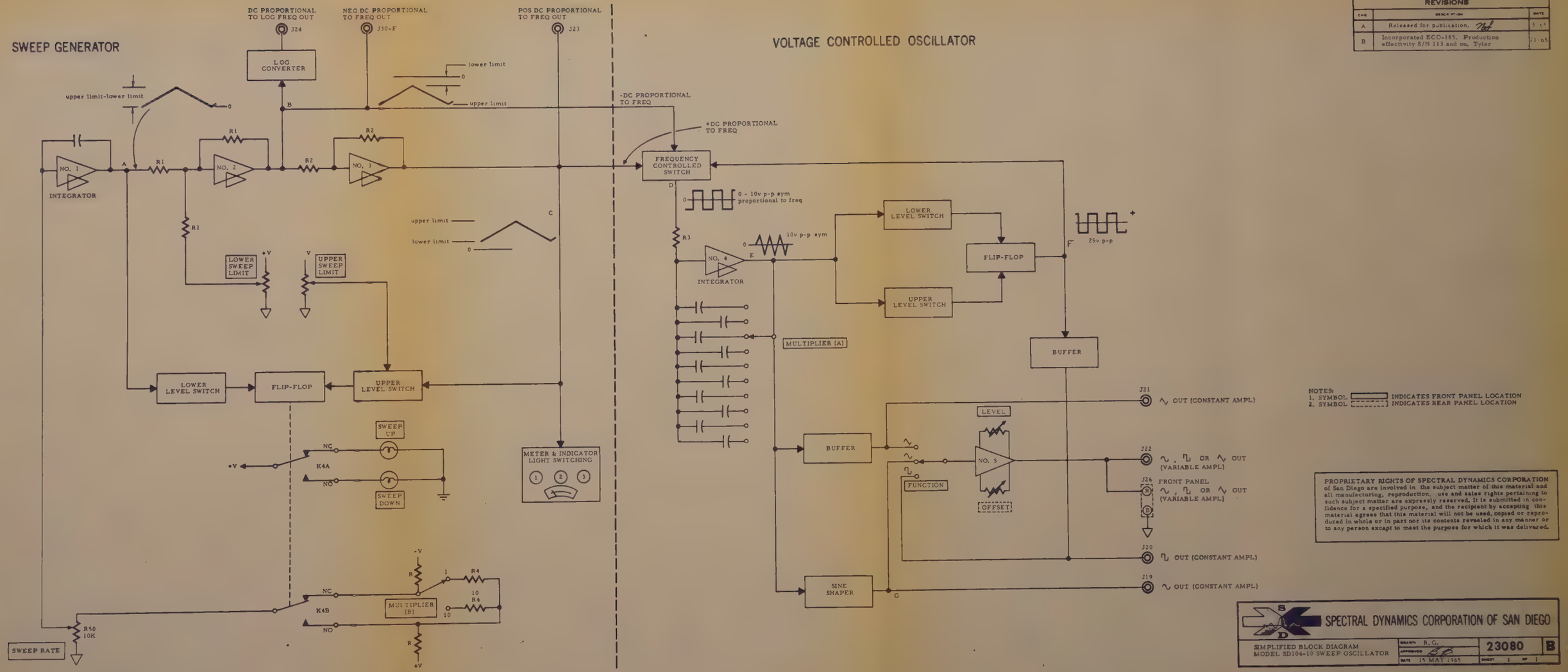
The VCO is a high speed integrator which runs between an upper and lower voltage level to produce a triangle wave. The time constant of this integrator (Amplifier #4) is set by the value of R3 (fixed)and the particular capacitor selected by MULTIPLIER (A) on the front panel. The slope of the triangle wave produced by Amplifier #4 is determined by the time constant selected and the polarity and magnitude of the dc voltage at point D. The Frequency Controlled Switch passes either the positive or the negative dc proportional to frequency, depending on the polarity of the square wave at point F. The Upper Level Switch and the Lower Level Switch are set to trigger at plus and minus 5 volts, respectively.

Assume that the bistable multivibrator is deenergized and the square wave at point F is negative. This negative voltage will cause the Frequency Controlled Switch to pass the negative dc proportional to frequency through R3 to Amplifier #4 and cause a positive going ramp at point E. When this ramp reaches a positive 5 volts, the Upper Level Switch will trigger and energize the bistable multivibrator. The voltage at point F will then be positive and the Frequency Controlled Switch will pass the positive dc proportional to frequency, causing a negative going ramp at point E. When this ramp reaches negative 5 volts, the Lower Level Switch will trigger and deenergize the bistable multivibrator. This process repeats itself, creating a triangle wave at point E. For a fixed setting of MULTIPLIER (A), the frequency of the triangle wave will be directly proportional to the magnitude of the dc supplied by the Sweep Generator.

The square wave at point F and the triangle wave at point E are buffered and available at the rear chassis BNC connectors J20 and J21,respectively.

The triangle wave at point E also drives the Sine Shaper, providing a sine wave of the same frequency as the triangle wave at connector J19.

Amplifier #5 is a Variable Gain, Variable Offset, Constant Output Impedance Amplifier. The front panel function switch permits the selection of a triangle, sine or square wave outputs available at the front panel output terminals or at J22, rear chassis BNC connector.




| REVISIONS | | |
|---|---|---|
| ENG | DESCRIPTION | DATE |
| A | Released for publication. | 5-65 |
| B | Incorporated ECO-185. Production effectivity S/N 113 and on. Tyler | 11-65 |

NOTES:
1. SYMBOL ▭ INDICATES FRONT PANEL LOCATION
2. SYMBOL ▭ INDICATES REAR PANEL LOCATION

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SIMPLIFIED BLOCK DIAGRAM
MODEL SD104-10 SWEEP OSCILLATOR

DRAWN R.G.
APPROVED
DATE 15 MAY 1965

23080 B

SHEET 1 OF 1

Figure 3

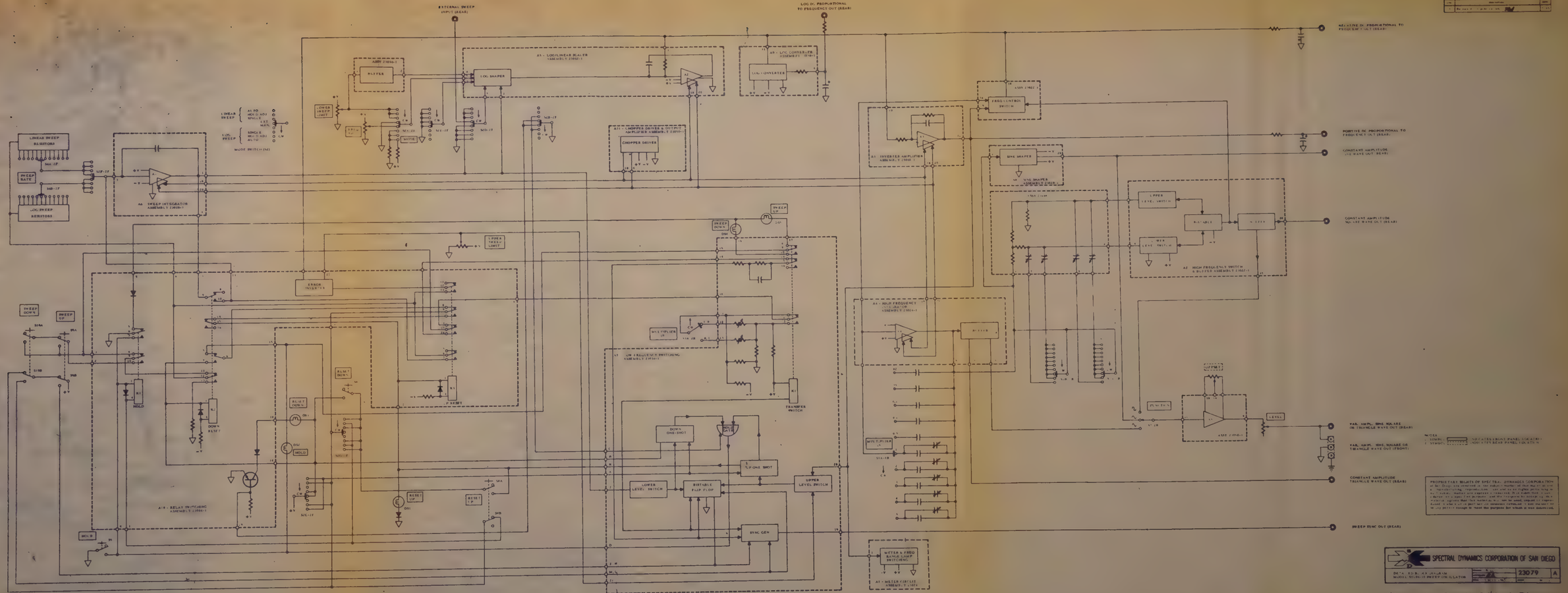



Figure 4. Detailed Block Diagram

## SECTION IV

## CALIBRATION

### 4.1 INTRODUCTION

The Model SD104 Sweep Oscillator has been carefully calibrated at the factory. However, after prolonged use or major parts replacement, it may be necessary to recalibrate the instrument according to the procedure contained in this section.

Unless otherwise directed, the digital voltmeter used throughout the following calibration procedure should be grounded to the ground buss common to the rear chassis BNC connectors.

Test points and adjustments are referred to by circuit card "A" number throughout the calibration procedure. For example, adjustment of R12 on card A6 will be noted as A6R12; test point 3 on card A6 will be noted as A6TP3, etc. All card receptacles (except A10) have one or two nylon "keys" inserted in line with black dots on the top side of the chassis, adjacent to the receptacle. The circuit card extension assembly should be used when necessary to gain easy access to test points. To install the extension card, remove the nylon key(s) in the chassis receptacle using a pair of long nose pliers. Replace the key(s) after the card extension is removed.

CAUTION

Always disconnect the ac power cord from the instrument when removing and replacing circuit card assemblies.

### 4.2 METER

Before applying power to the instrument, set the meter mechanical zero adjust screw so that the pointer of the meter is resting exactly on 1.

### 4.3 POWER SUPPLY

Apply ac line power to the unit and rotate the front panel LEVEL control clockwise, turning the unit on. With a digital voltmeter connected to A12TP2, adjust A12R16 for negative 15 volts dc. Connect the voltmeter to A12TP3 and adjust A12R8 for positive 15 volts dc.

Using an oscilloscope, measure the ac ripple at A12TP2 and A12TP3. The ripple should not exceed 1.5 millivolts peak-to-peak, referenced to circuit ground.

### 4.4 METER CALIBRATION

Mount circuit card A1 on the extension assembly in the A1 receptacle. Set the front panel mode switch to the MAN. position and the FREQ ADJ and VERNIER controls to their extreme counter-clockwise positions. Ground the digital voltmeter directly to some point originating from pin 20 of card A1.

## 4.4 METER CALIBRATION (Cont'd)

Measure the voltage at A1TP1, which should be a positive 10 millivolts, plus or minus 1.0 millivolt. At A1TP2 it should be 100 millivolts plus or minus 1 millivolt, and at A1TP3 it should be 1 volt, plus or minus 0.01 volt.

Remove circuit card extension assembly and replace circuit card assembly A1.

Connect the digital voltmeter to J23, BNC rear chassis connector, and with the FREQ ADJ and VERNIER controls on the front panel, set the dc-proportional-to-frequency voltage to 9.999 volts. Adjust SHUNT potentiometer A1R33 for a reading of 10 on the front panel frequency meter, with the decade indicator light to the far right (highest decade) illuminated.

Set the dc-proportional-to-frequency voltage to 100 millivolts and adjust SERIES potentiometer A1R34 for a reading of 10 on the front panel frequency meter, with the decade light to the far left (lowest decade) illuminated. If A1R34 has insufficient range to set the meter correctly, select a different value for A1R32 that will allow this adjustment to be made.

Repeat the previous two steps until both conditions are properly met.

Adjust 2ND DECADE potentiometer A1R21 so that the decade indicator lights switch from the lowest decade to the middle decade just as the meter pointer reaches 10.2 (last marked division), as the FREQ ADJ control is slowly brought through this point in a clockwise direction.

Adjust the 3RD DECADE potentiometer A1R10 so that the decade indicator lights switch from the middle decade to the highest decade just as the meter pointer reaches 10.2 (last marked division), as the FREQ ADJ control is slowly brought through this point in a clockwise direction.

## 4.5 CHOPPER DRIVE

Adjust DRIVE potentiometer A11R10 for 3.4 volts peak-to-peak at A11TP3, as measured with an oscilloscope.

## 4.6 UP RESET SERVO

Mount circuit card A10 on the extension assembly in the A10 receptacle. Place the front panel mode switch in the SINGLE LINEAR SWEEP position and depress the RESET UP pushbutton. Connect a digital voltmeter to A10TP1 and rotate the UPPER LIMIT control fully counter-clockwise, noting the reading on the voltmeter. Connect the voltmeter to A10TP2 and adjust OFFSET potentiometer A10R10 for the same reading, but of opposite polarity.

## 4.6 UP RESET SERVO(Cont'd)

Reconnect the voltmeter to A10TP1 and adjust the UPPER LIMIT control for a reading of approximately 9 volts, and note this reading. Reconnect the voltmeter to A10TP2 and adjust BALANCE potentiometer A10R15 for the same reading, but of opposite polarity. Repeat until the voltage at A10TP1 tracks the voltage at A10TP2 within 2 millivolts.

Remove circuit card extension assembly and replace circuit card assembly A10.

## 4.7 OFFSET ADJUSTMENT

Set the front panel mode switch to the MAN. position. Connect a digital voltmeter to the center terminal lug (wiper) of the FREQ ADJ potentiometer and rotate both the FREQ ADJ and VERNIER controls as necessary to obtain a reading of 10 millivolts.

Connect the voltmeter to J30-F and adjust OFFSET potentiometer A5R17 for negative 10 millivolts.

Connect the voltmeter to J23 and adjust OFFSET potentiometer A3R8 for positive 10 millivolts.

Mount circuit card A6 on the extension assembly in the A6 receptacle. Set the mode switch in the SINGLE LINEAR SWEEP position and depress the RESET DOWN pushbutton. Connect the digital voltmeter to A6TP2 and adjust OFFSET potentiometer A6R10 for a reading of zero, plus or minus 0.02 millivolts.

Repeat the preceding adjustments as necessary and recheck the measurements to ensure that the settings of the OFFSET potentiometers are correct.

Remove circuit card extension and replace circuit card assembly A6.

## 4.8 TRIANGLE WAVE ADJUSTMENT

With the mode switch in the MAN. position, set the FREQ ADJ control for some frequency meter indication with the middle decade indicator light on. Set MULTIPLIER (A) to the 0.1 position and connect an oscilloscope probe to A4TP2. (Note: The scope must be calibrated and used in the dc coupled mode.) Adjust UPPER potentiometer A2R1 until the upper peak of the triangle wave is exactly 5 volts above ground.

## 4.9 SYMMETRY ADJUSTMENT

Set the mode switch to the MAN. position and both the FREQ ADJ and the VERNIER controls fully couter-clockwise. Turn the LEVEL control fully clockwise. With front panel FUNCTION switch, select the square wave output and set MULTIPLIER (A) in the 20 position. Monitoring the front panel output terminals with an oscilloscope, adjust OFFSET potentiometer A4R2 for time symmetry of the square wave.

## 4.10 SWEEP ZERO ADJUSTMENT

Connect the X axis of a dc recorder (Moseley 136 or equivalent) to J23 (dc voltage proportional to frequency), BNC rear chassis connector.

Set the mode switch to SINGLE LINEAR SWEEP. Press the RESET DOWN pushbutton. Set the LOWER SWEEP LIMIT for a frequency reading of 5 in the lowest decade. Press the RESET UP button. Set the UPPER SWEEP LIMIT for a frequency reading of 10 in the highest decade.

Adjust the dc recorder to place the pen at the left and right margins when in the DOWN and UP reset modes respectively.

Set the mode switch to AUTO (LINEAR SWEEP) and press the RESET DOWN pushbutton. Note the exact position of the recorder when it comes to rest.

Set SWEEP RATE FOR 5 Hz/sec and MULTIPLIER (B) to 1.0. Momentarily press SWEEP UP pushbutton. When the plotter pen has moved away from the left margin by an inch or so, momentarily press the SWEEP DOWN pushbutton. Note the amount by which the plotter pen undershoots or overshoots the "rest" position of the RESET DOWN mode (see previous paragraph). Repeat the up and down sweeps, adjusting ZERO potentiometer A7R21 for zero overshoot or undershoot.

## 4.11 SWEEP UPPER LIMIT

With the recorder still connected to J23, push the RESET UP button and note position on recorder. Using the techniques described in paragraph 4.10, adjust TRANSFER potentiometer A7R51 for zero overshoot or undershoot.

## 4.12 LOG CONVERTER

Disconnect the instrument from the ac power line and remove circuit card assemblies A2, A3, A4 and A5 from the chassis. Connect a 10k ohm resistor from A9TP4 to A9TP3 and attach a jumper wire between A9TP1 and A9TP2. Restore ac power, connect a digital voltmeter to A9TP3(Ground lead to A9TP2) and adjust ZERO potentiometer A9R4 for zero volts, plus or minus 0.02 millivolts.

Connect the voltmeter to A9TP4(Ground lead to A9TP2)and adjust LIN potentiometer A9R13 for zero, plus or minus 0.02 millivolts.

Disconnect the instrument from the ac power line and reinstall circuit card assemblies A2, A3, A4, A5 and A9. Restore the ac power. Place the mode switch in MAN. mode. Connect the dc recorder, with 3 cycle log paper in place, to connector J24. Connect a digital voltmeter to J24 (dc proportional to frequency), and adjust the recorder for full scale operation between 10 millivolts and 10 volts, using FREQ ADJ control on the front panel of the SD104 to vary the dc. Adjust the frequency control so that the recorder is set to the top of the first decade on the 3 cycle paper. The voltmeter should read 100 millivolts, plus or minus 1.5 millivolts.

Adjust the frequency control so that the recorder is set to the second decade point on the 3 cycle paper. The digital voltmeter should read 1 volt, plus or minus 15 millivolts.

## 4.12 LOG CONVERTER (Cont'd)

Note: The LIN potentiometer A9R13 may have to be readjusted to obtain the above accuracy. If this becomes necessary, adjust the frequency control for a digital voltmeter reading of 100 millivolts. Note the error shown on the plotter. Adjust A9R13 so as to double the error. Reset the plotter end points at the 10 millivolt and 10 volt settings and recheck the linearity as described above. Repeat this procedure as necessary.

## 4.13 LINEARIZATION

NOTE

The following adjustments should be made with circuit cards A3 and A4 plugged directly into their receptacles. Do not use the extender card assembly. Adjust the capacitors with an offset screwdriver.

Set MULTIPLIER (A) to the 0.5 position and the mode switch to MAN. With the voltmeter connected to J23, set the dc-proportional-to-frequency to 100 millivolts. Adjust FREQ potentiometer A2R33 for 5.000 Hz (period of 200 milliseconds) at J19, using a frequency counter.

Set MULTIPLIER (A) to the 1 position and adjust C11(*) for 10 Hz (period of 100.0 milliseconds).

Set MULTIPLIER (A) to the 2 position and adjust C13(*) for 20 Hz (period of 50.0 milliseconds).

Set MULTIPLIER (A) to the 5 position and adjust C15(*) for 50 Hz.

Set MULTIPLIER (A) to the 10 position and adjust C17(*) for 100 Hz.

Set MULTIPLIER (A) to the 20 position and adjust C19(*) for 200 Hz.

(*) Mounted on MULTIPLIER (A) Switch - See Figure 5.

Connect an oscilloscope that has at least a 10 megacycle bandpass (Tektronix 545 or equivalent) to A4TP2 and set MULTIPLIER (A) to the 10 position.

Adjust A3C2 and A3C4 so that the amplitude variation of the triangle wave is minimized over a range of 10 Hz to 10,000 Hz, and the variations in the positive and negative peaks are symmetrical with respect to circuit ground. Make sure that when the front panel meter indicates 10,000 Hz, that the actual output frequency is 10,000 Hz, plus 60 Hz, minus 0 Hz. If necessary, make further adjustment of A3C2 and A3C4.

Set MULTIPLIER (A) to the 20 position. Connect the oscilloscope to A3TP2 and adjust A3C1 and A3C3 so that the amplitude variation of the triangle wave is minimized over a range of 20 Hz to 20,000 Hz, and the variations in the positive and negative peaks are symmetrical with respect to circuit ground. Make sure that when the front panel

## 4.13 LINEARIZATION (Cont'd)

meter indicates 20,000 Hz, that the actual output frequency is 20,000 Hz, plus 100 Hz, minus 0 Hz. If necessary, make further adjustment of A3C1 and A3C3.

## 4.14 SINE SHAPER

The adjustment of the Sine Shaper, circuit card A8, will require a dual trace oscilloscope and a distortion analyzer (H-P Model 330D or equivalent).

With a soldering iron, heat and disconnect one end of the short buss wire jumper between the base of A8Q1 & the junction of A8CR4 & A8CR5.

Set the SD104A for 200 Hz, MAN. mode, with the MULTIPLIER (A) in the .1 position. Attach the distortion analyzer and oscilloscope probe to J19 (Constant Amplitude Sinewave output). Adjust A8R20 & A8R16 so that the waveform is approximately symmetrical about ground and has a nominal value of 2 to 3 volts peak-to-peak.

Distortion may be minimized by the adjustment of A8R1, A8R5, A8R10 and A8R13. Repeat the preceding adjustments and note the resulting distortion. If the distortion is not less than .3%, turn A8R13 ¼-turn clockwise and then optimize A8R1, A8R5 and A8R10. If the distortion is then lower than the previously noted reading, continue the adjustment of A8R13 in ¼-turn increments in a clockwise direction (optimizing A8R1, A8R5 and A8R10 each time) until no further improvement is noted.

If the preceding step does not improve the distortion, adjust A8R13 in ¼-turn increments in a counter-clockwise direction (optimizing A8R1, A8R5 and A8R10 each time) until no further improvement is noted.

Reconnect and solder the buss wire jumper previously disconnected between A8R21 and A8R24 and adjust LIMIT potentiometer A8R32 for minimum distortion.

Attach the oscilloscope probe to J22 (Variable Amplitude Output). Set the front panel FUNCTION selector for a sinewave output and the LEVEL control for maximum. Adjust A8R16 for approximately 10.5 volts peak-to-peak sinewave at J22.

Return probe to J19 and adjust A8R20 for zero dc offset.

NOTE: For absolute minimum distortion, allow the instrument to warm up for approximately 1 hour with the top cover set in place but not screwed down. Remove the top cover and make a final re-adjustment of A8R1 and A8R5 for minimum distortion.

## 4.15 OUTPUT AMPLIFIER

Turn the front panel LEVEL control fully clockwise and connect an oscilloscope to the front panel OUTPUT jack. Adjust the BAL potentiometer A11R24 so that the OFFSET control on the rear of the chassis will vary the offset of the sinewave variable output equally in a positive and negative direction.

## 4.16 HOLD DRIFT

Set the mode switch to SINGLE LINEAR SWEEP and press the DOWN RESET pushbutton. Start an UP sweep and depress the HOLD pushbutton while in the lowest decade range. After a period of two minutes, adjust A6R5 for minimum upward drift. Drift should be less than 2 millivolts per minute as measured at J23.

## 4.17 SWEEP TIME

Set mode switch to SINGLE LINEAR SWEEP. Set SWEEP RATE control to 10 (Make sure dial is correctly zeroed). Set MULTIPLIER (B) to 10 and time a single UP sweep, which should have a duration of 49.95 seconds, plus or minus .5 seconds for a full 3-decade sweep. If necessary, adjust FAST potentiometer A7R72 for correct timing.

Set MULTIPLIER (B) to 1. Sweep time should now measure 499.5 seconds, plus or minus .5 seconds. If necessary, adjust SLOW potentiometer A7R75 for correct timing.

Return MULTIPLIER (B) to 10 and change mode switch to SINGLE LOG SWEEP. Time a single UP sweep, which should measure 18 seconds, plus or minus .1 second. If necessary, adjust LOG GAIN potentiometer A5R4 for correct timing.

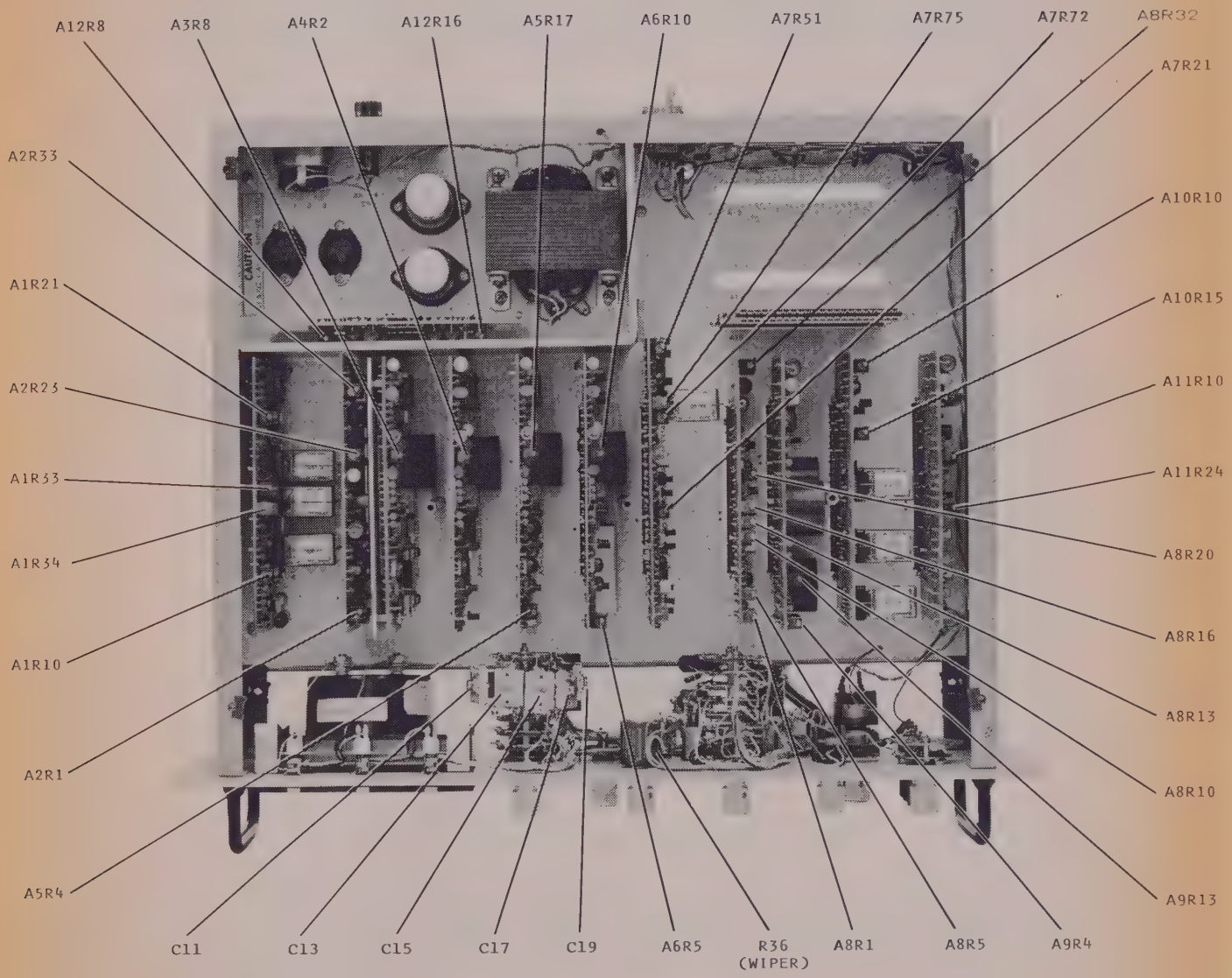



Figure 5. Top Chassis View

## SECTION V

## REPLACEABLE PARTS

### 5.1 GENERAL

Standard electronic components have been used in this instrument wherever possible. However, certain design features and innovations call for certain special components in some cases. A complete listing of all the module type printed circuit card assemblies and special components are contained in this section.

Spectral Dynamics Corporation maintains a complete stock of all parts used in this instrument, including complete printed circuit board assemblies. When ordering replacement parts or assemblies, always include, in addition to any assigned stock number information listed below, a complete description of the item being ordered, the reference designation and the model and serial number of the equipment.

### 5.2 SPECIAL REPLACEABLE PARTS LIST

| Reference Designation | Description | Part No. or Mfr. Desig. |
|---|---|---|
| A1 | Meter Circuit Assembly | 23024-1 |
| A2 | High Freq.Switch & Buffer Assy | 23022-1 |
| A3 | Inverter Amplifier Assembly | 23048-1 |
| A4 | High Freq. Integrator Assembly | 23046-101 |
| A5 | Log/Linear Scaler Assembly | 23044-1 |
| A6 | Sweep Integrator Assembly | 23028-1 |
| A7 | Low Freq. Switching Assembly | 23034-1 |
| A8 | Sine Shaper Assembly | 23020-3 |
| A9 | Log Converter Assembly | 23038-1 |
| A10 | Relay Switching Assembly | 23044-1 |
| A11 | Chopper Driver & Output Amp.Assy | 23050-1 |
| A12 | Power Supply Assembly | 23036-1 |
| A13 | (not used) | |
| A14 | (not used) | |
| A15 | Circuit Card Extension Assy | 23060-1 |
| A3A1<br>A4A1<br>A5A1<br>A6A1 | Solid State Chopper Assy(potted) | 23026-1 |
| A9A1<br>A9A2<br>A9A3 | Transistor,(potted)Matched Pair Assembly 23032-1 (2N3391A) | 20013-044 |
| A1Q3A & A1Q3B<br>A1Q6A & A1Q6B | Transistor,(cemented)Matched Pair Assembly 23054-1 (2N3391A) | 20013-045 |

## 5.2 SPECIAL REPLACEABLE PARTS LIST (Cont'd)

| Reference Designation | Description | Part No. or Mfr. Desig. |
|---|---|---|
| A2Q10A & A2Q10B<br>A11Q8 & A11Q9 | Transistor, Matched Pair (2N1304/2N1305) | 20013-042 |
| A2Q1, A2Q7<br>A3Q5, A8Q2<br>A8Q6, A5Q5<br>A8Q8, A6Q5<br>A7Q1, A7Q13<br>A7Q16, A9Q3<br>A9Q6 | Transistor, Selected (2N3638) | 20013-048 |
| A1Q2, A1Q5<br>A7Q18, A4Q5 | Transistor, Selected (2N3638A) | 20013-074 |
| A11Q1, A11Q2 | Transistor, Selected(2N1304) | 20013-082 |
| A8Q3 | Transistor, Selected(2N3277) | 20013-050 |
| M1 | Meter, Front Panel | 20013-064 |
| S1 | Switch, Multiplier (A) | 23030-1 |
| S2 | Switch, Mode Selector | 20013-054 |
| S7 | Switch, Function | 20013-055 |
| S13 | Switch, Multiplier (B) | 20013-072 |
| R50 | Potentiometer, 10K, Sweep Rate | BOURNS 3500S-2-103 |
| | Multi-Dial, Sweep Rate Control | SPECTROL 11-1-11 |
| T1 | Transformer, Power | 20013-049 |

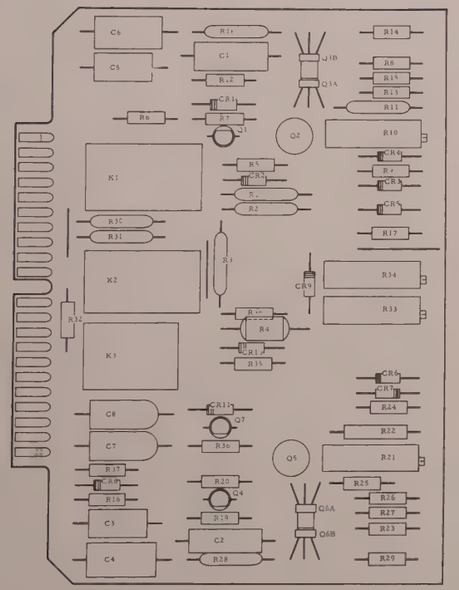


Figure 6. Component Location - Circuit Card A1
Meter Circuit Assembly 23024-1

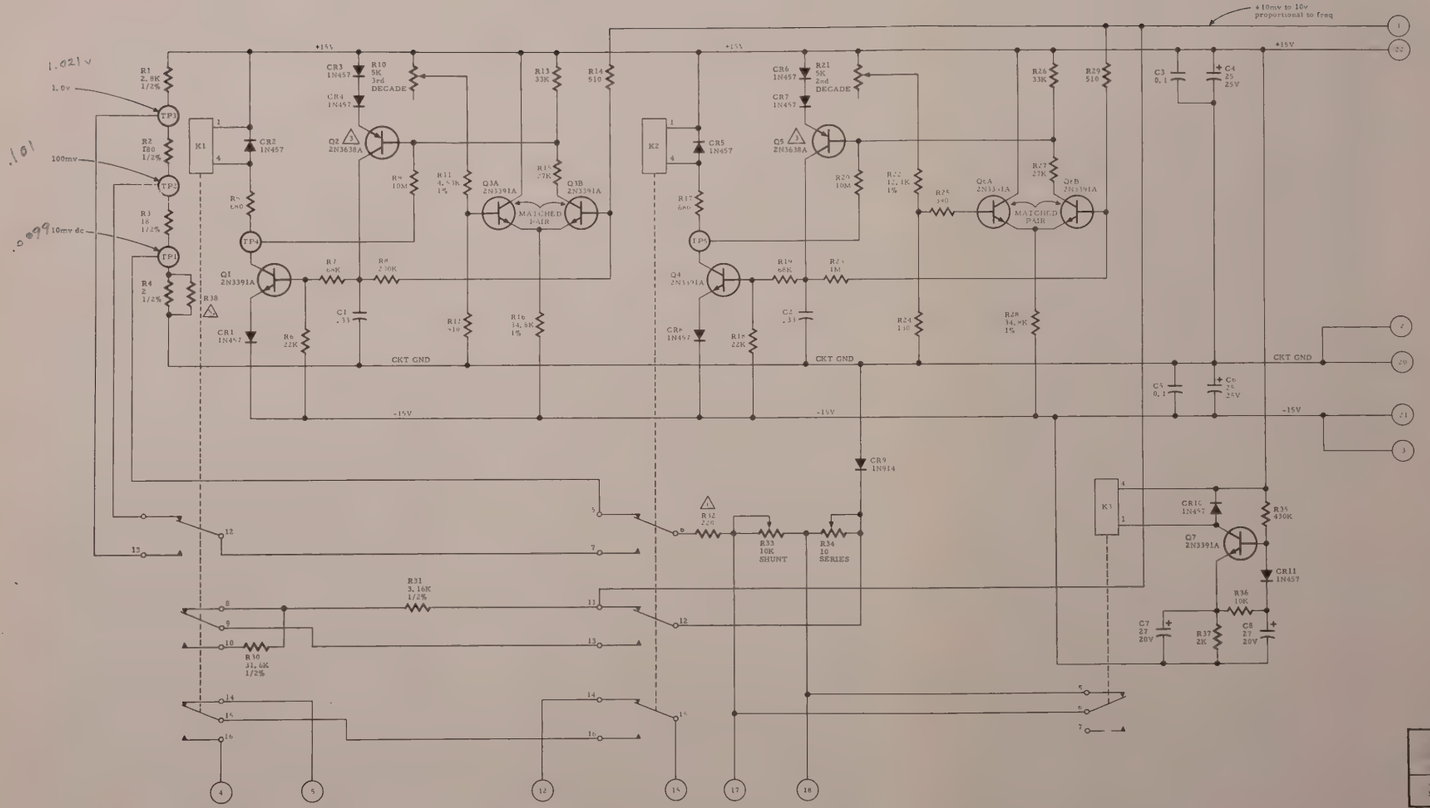



Figure 7. Schematic - Circuit Card A1

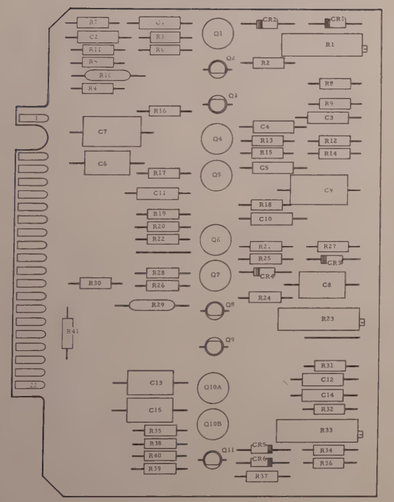
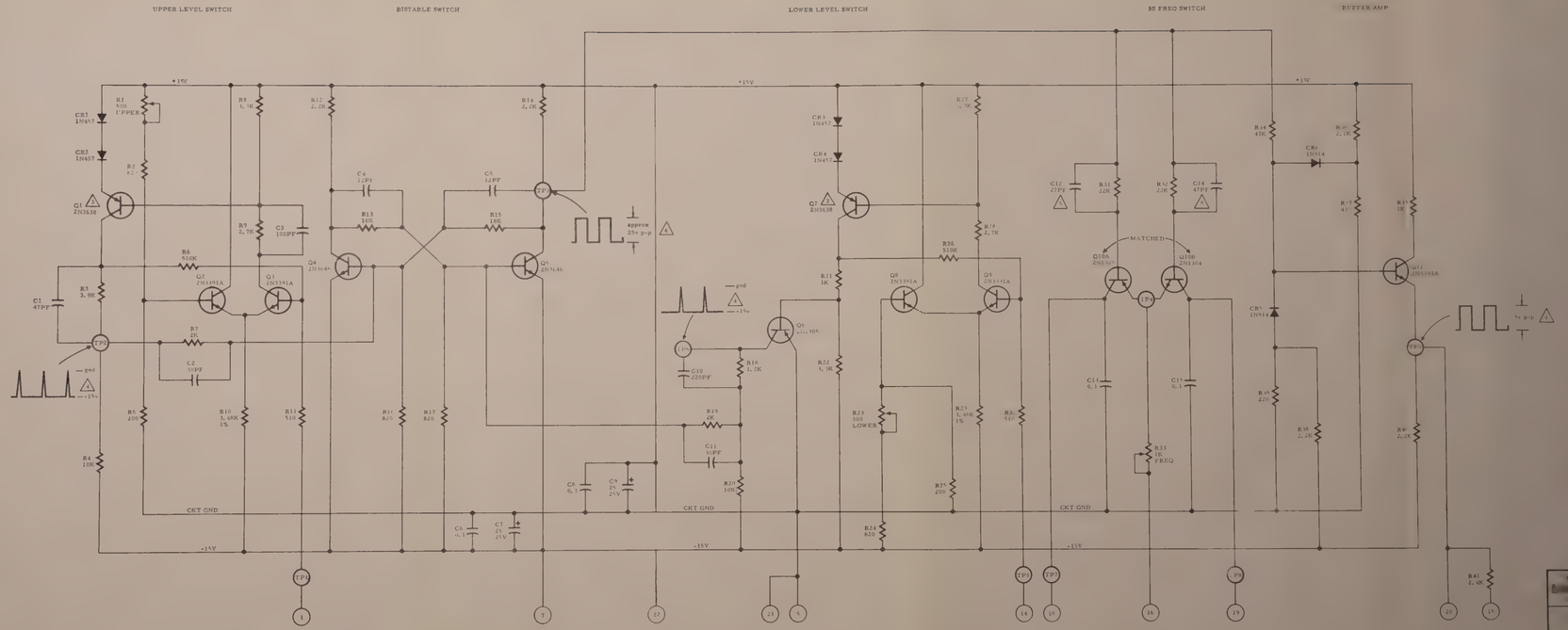


Figure 5. Component Location - Circuit Card A2
High Frequency Switch & Buffer Assembly 23022-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released for production | 2-67 |
| B | Incorporated ECO-181, Effectivity: S/N 111 & subs. Dunham | 8-68 |
| C | Incorporated ECO-228. Effectivity: S/N 113 and subs. | 11-68 |

NOTES:
1. RESISTOR VALUES IN OHMS, K = 1,000, M = 1,000,000 AND CAPACITOR VALUES IN MICROFARADS, P FOR MICROMICROFARADS, INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   DIODES CR9 TRANSISTORS Q11 RESISTORS R41 CAPACITORS C15
△ FACTORY SELECTED
△ SAME FREQUENCY (A) OUTPUT
△ FACTORY ADJUSTMENT WITH OPTIMUM VALUE SHOWN

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC
HIGH FREQ SWITCHING AND BUFFER ASSEMBLY 23003

DRAWN | APPROVED | DATE | SIZE: D | 23003 | C

Figure 6. Circuit Card A2

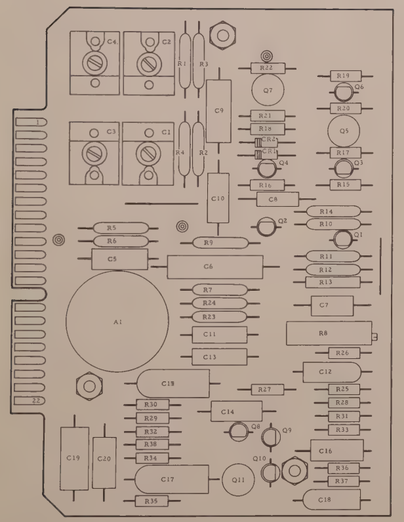
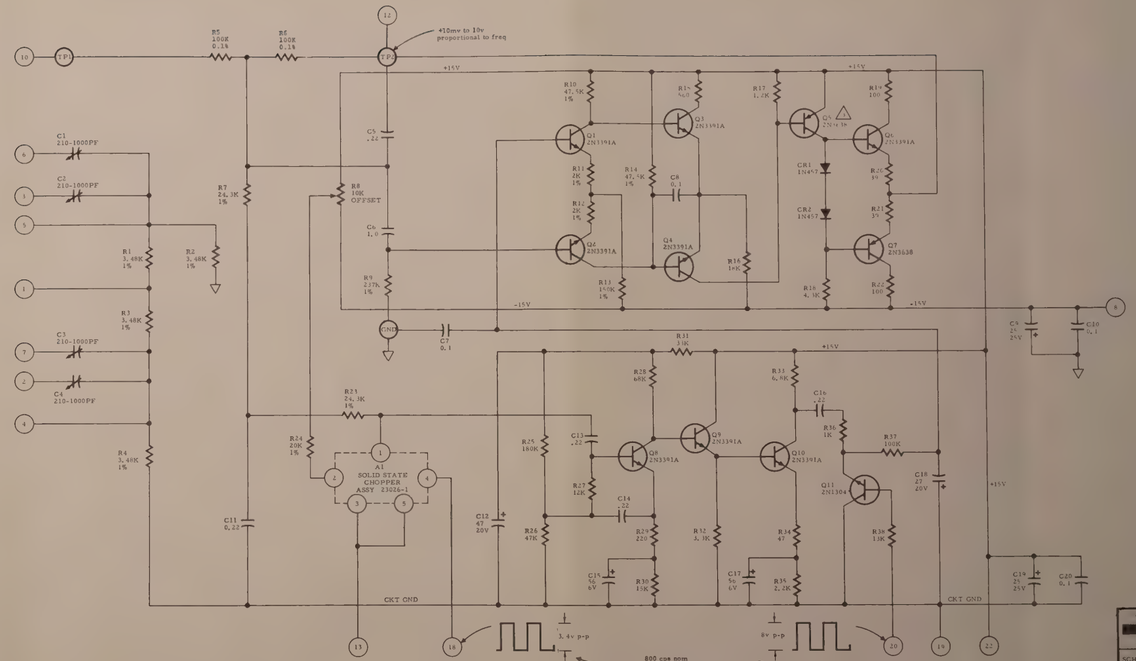



Figure 10. Component Location - Circuit Card A3
Inverter Amplifier Assembly 23048-1

| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released per ECN No. 432 | 2-71 |
| B | Incorporated ECN-480. Production effectivity S/N 211 & on. | 4/84 |




NOTES:

1. RESISTOR VALUES IN OHMS @ 1W, 5% AND CAPACITOR VALUES IN MICROFARADS @ 200V, UNLESS OTHERWISE INDICATED.
2. HIGHEST REFERENCE DESIGNATORS USED:
   A1 C26 CR2 Q15 R58 TP2

⚠1 FACTORY SELECT TO SDC SPEC. 20023-048.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC -
INVERTER AMPLIFIER ASSEMBLY 23048-1

DRAWN R.C.C. | 23004 | B

APPROVED | SCALE NONE | SHEET 1 OF 1

Figure 11. Schematic - Circuit Card A3

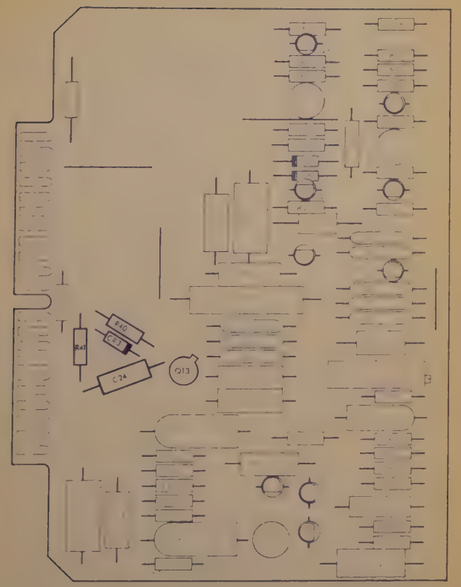
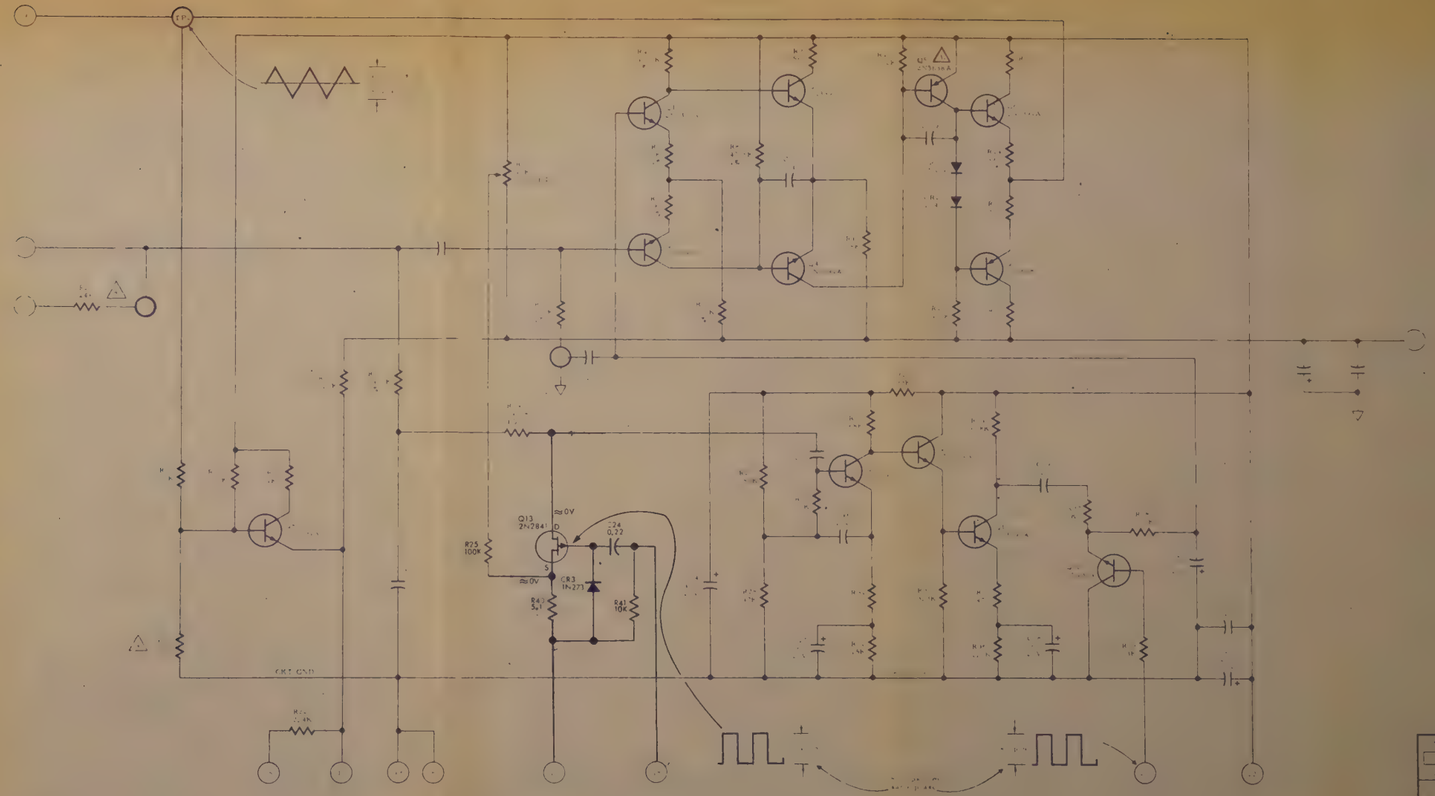


Figure 12




| REVISIONS | | |
|---|---|---|
| | | |
| | | |
| | | |
| C | ECO-314 | 6/67 |

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

23070 C

Figure 13. Circuit Card A4

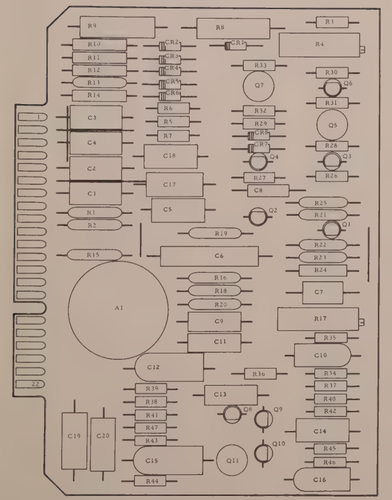
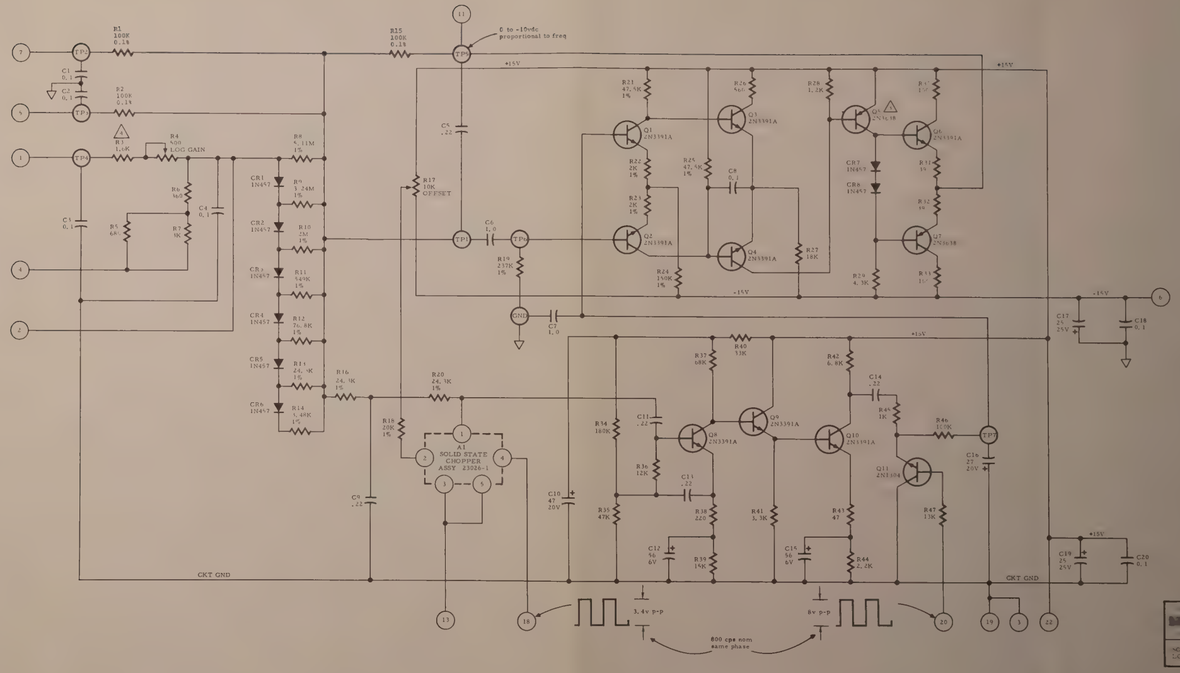



Figure 14. Component Location - Circuit Card A5
Log/Linear Scaler Assembly 23042-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| C | Re-released per ECO-177. Effective S/N 11 | 6/84 |
| D | Re-released per ECO-225. Production effectivity S/N 213 & On. | 3/85 |
| L | Incorporated ECO-251. Production effectivity S/N 313 & On. | 8/86 |

NOTES:

1. RESISTOR VALUES IN OHMS @ 1/4W, 5% AND CAPACITOR VALUES IN MICROFARADS @ 200V, UNLESS OTHERWISE INDICATED.
2. HIGHEST REFERENCE DESIGNATORS USED:
   A1 L20 C88 Q11 R47 TP7
3. FACTORY SELECT TO SOC SPEC. 29013-048.
4. FACTORY ADJUST WITH OPTIMUM VALUE SHOWN.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC
LOG/LINEAR SCALER ASSEMBLY 23042-1

DRAWN: R.G.
CHECKED:
DATE: 1-29-85

23006 D

SHEET 1 OF 1

Figure 15. Schematic - Circuit Card A5

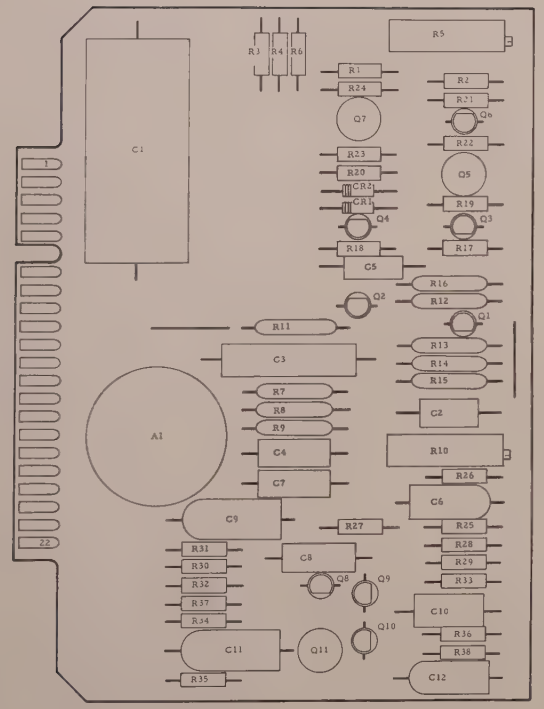
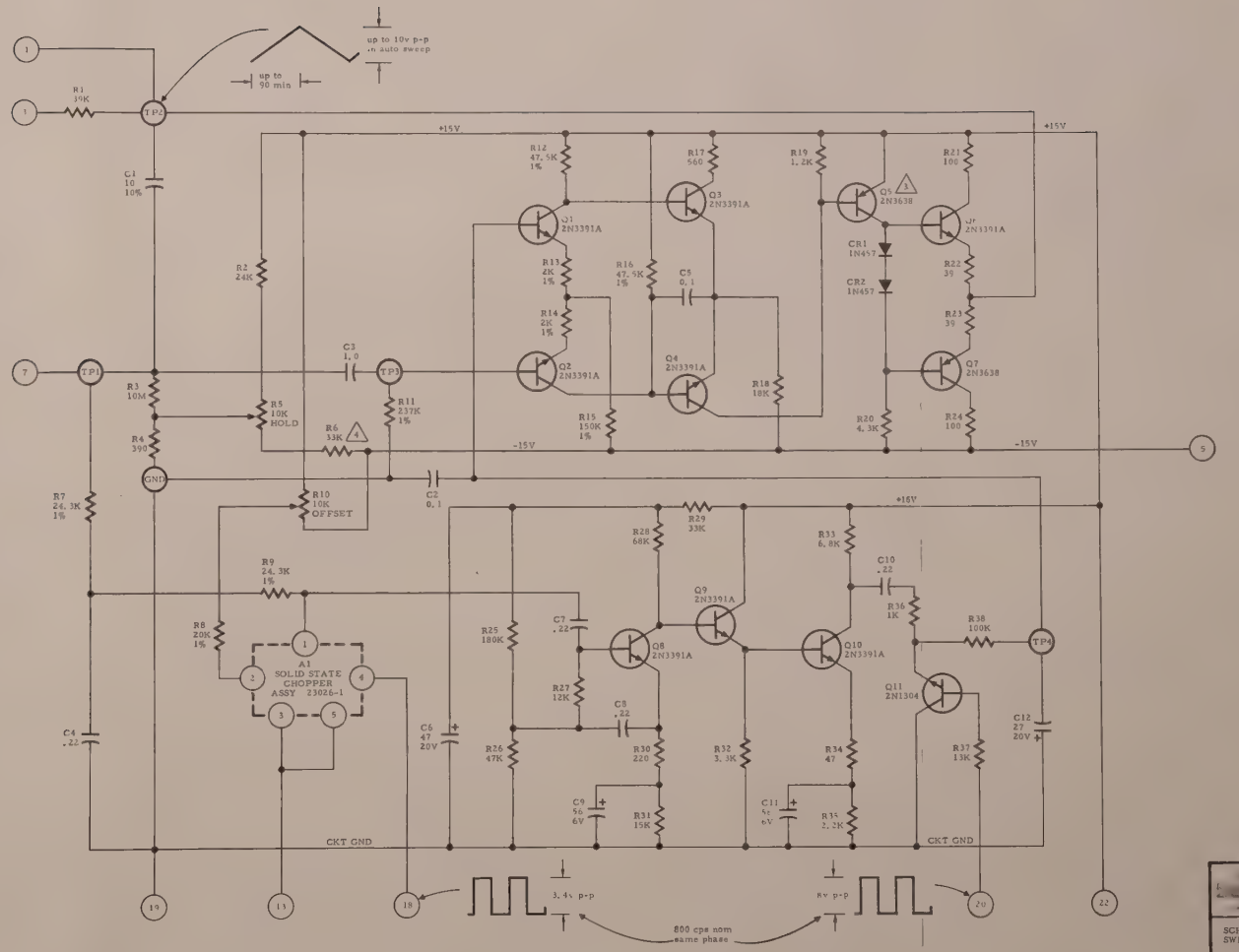



Figure 16. Component Location - Circuit Card A6
Sweep Integrator Assembly 23028-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Revised per ECO [illegible] | [illegible] |

NOTES:

1. RESISTOR VALUES IN OHMS, @ 1/2W, 5%, AND CAPACITOR VALUES IN MICROFARADS, @ 200V, UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   A1 C12 CR2 Q11 R38 TP4

△3 FACTORY SELECTED.

△4 FACTORY ADJUST WITH NOMINAL VALUE SHOWN.

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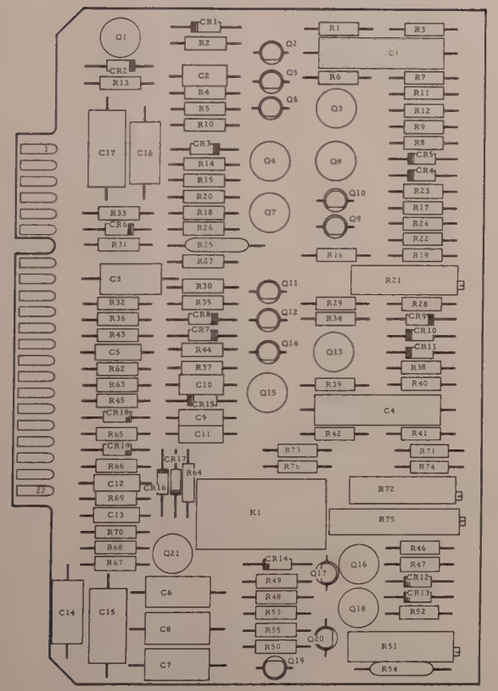
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

| | | |
|---|---|---|
| SCHEMATIC- SWEEP INTEGRATOR ASSEMBLY 23028-1 | DRAWN R. G. | 23007 A |
| | APPROVED [illegible] | |
| | DATE 15 FEB 1965 | SHEET 1 OF 1 |

Figure 17. Schematic - Circuit Card A6



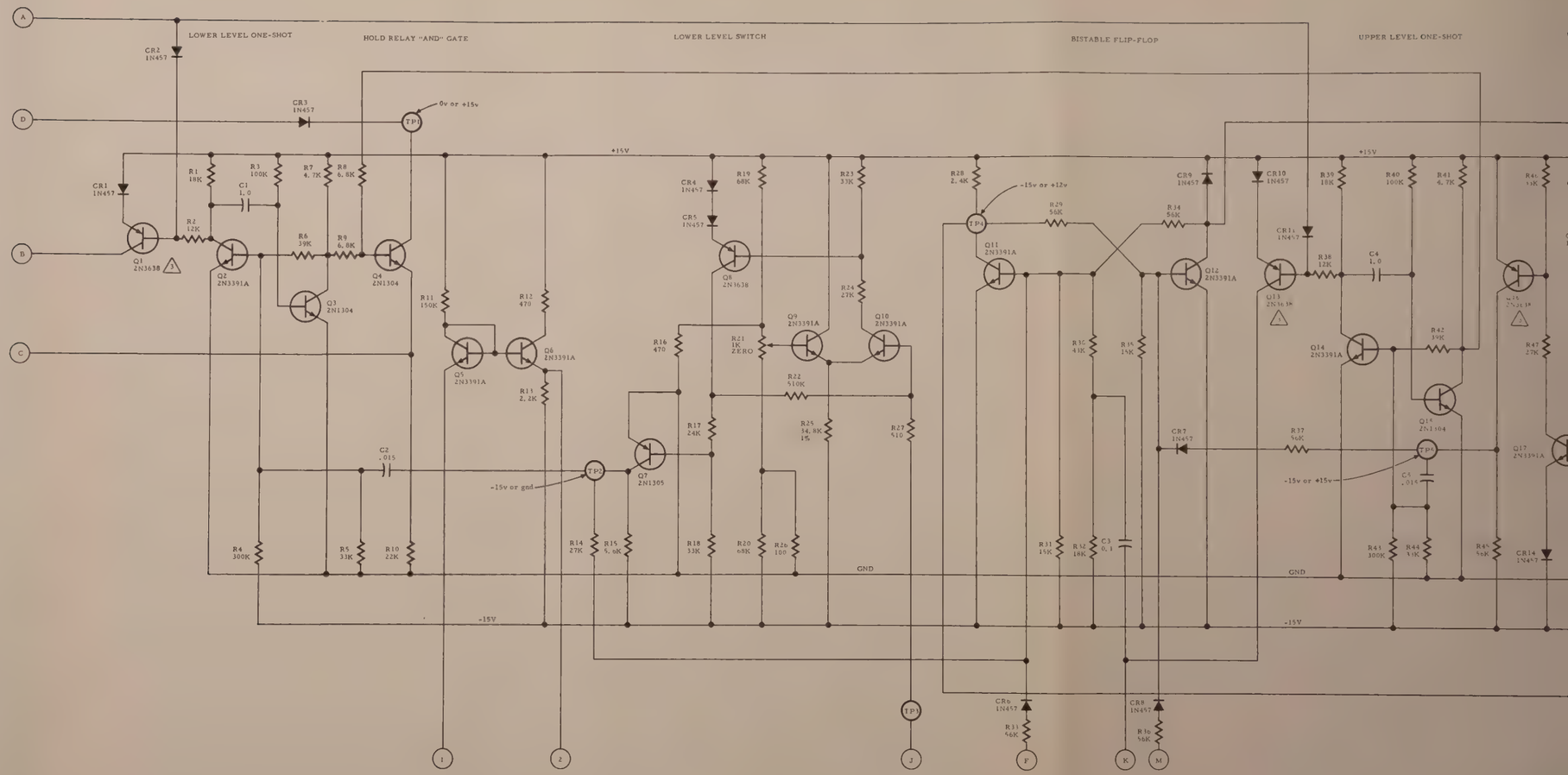
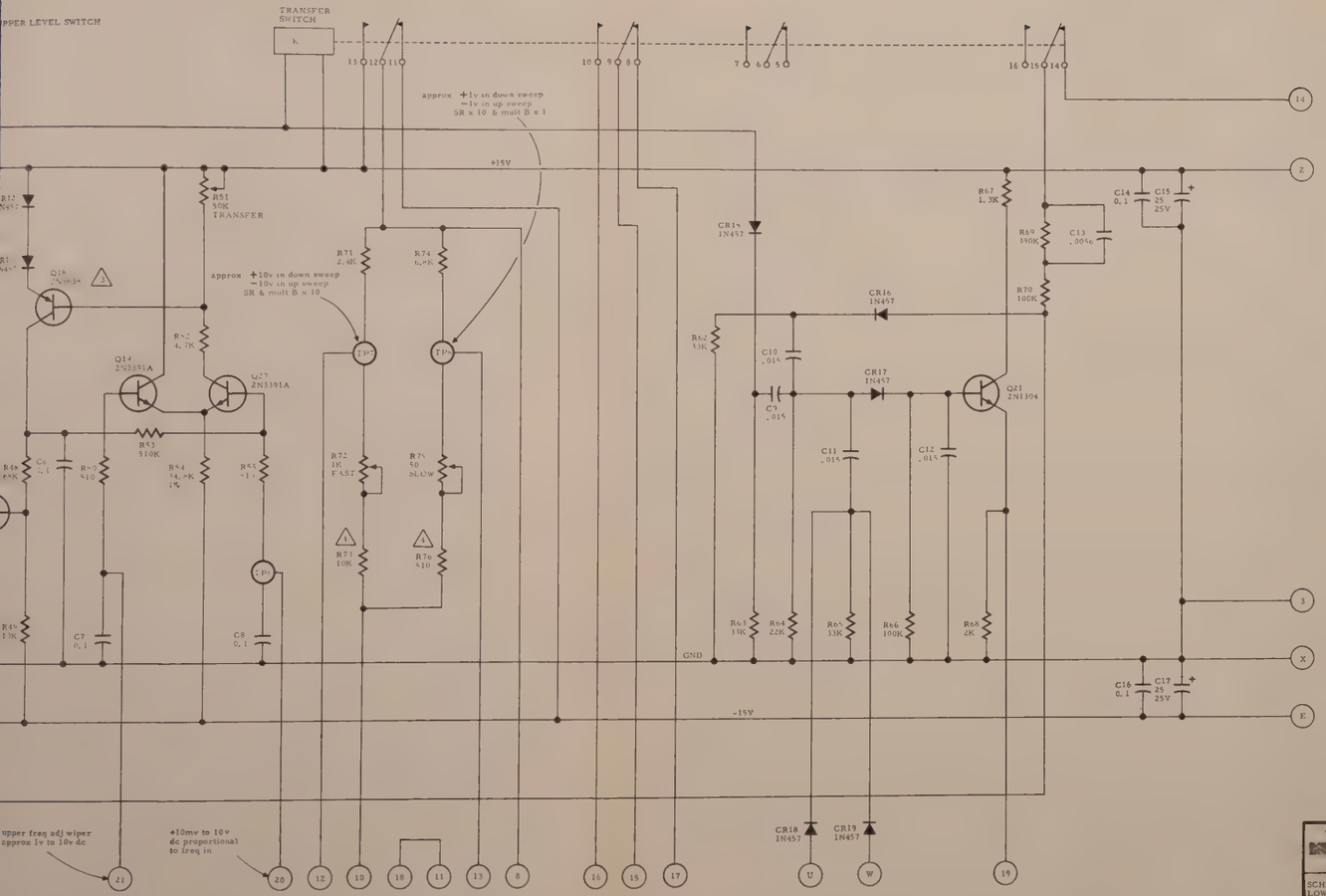



Figure 18 Component Location - Circuit Card A7
Low Frequency Switching Assembly 23034-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released to production. | 2/65 |
| B | Incorporated ECO-190, Effectivity S/N 63 and on. R. Garcia | 4/65 |
| C | Incorporated ECO-190A, Effectivity S/N 63 and on. R. Garcia | 5/65 |
| D | Incorporated ECO-190B. Effectivity S/N 63 and on. R. Garcia | 6/65 |
| E | Incorporated ECO-201, Production effectivity S/N 113 and on. R. Garcia | 7/65 |

NOTES:

1. RESISTOR VALUES IN OHMS, @ 1/2W, 5%, AND CAPACITORS IN MICROFARADS, @ 200V, UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:

   C17 CR19 K1 Q21 R76 TP8

△2 FACTORY SELECTED.

△4 FACTORY ADJUST WITH OPTIMUM VALUE SHOWN.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

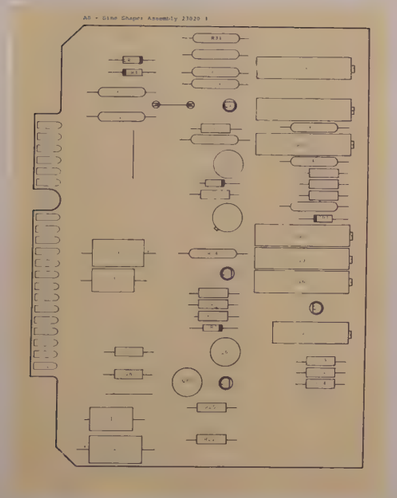
SCHEMATIC - LOW FREQ SWITCHING ASSEMBLY 23034-1

DRAWN R. G. | 15 FEB 1965

23008 E

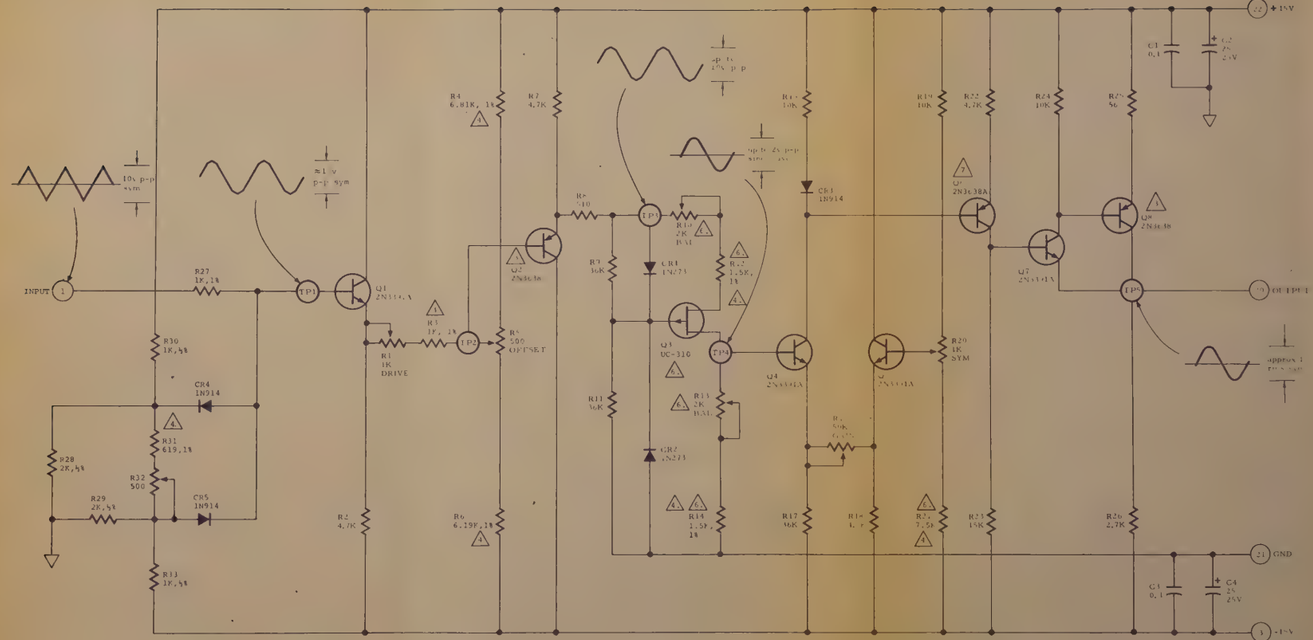
SHEET 1 OF 1

Figure 19 - Circuit Card A7




Figure

| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released for engineering by ECO-25[illegible] Model A8/W-1 & -2. | [illegible] |
| B | [illegible] ECO-25[illegible] Approved, W. Scott & [illegible], R. G[illegible] | [illegible] |
| C | [illegible] ECO-25[illegible] [illegible] W. Scott & [illegible], R. G[illegible] | [illegible] |
| D | Incorporated ECO 255. Production effectivity S/N 213 and on. | 4/65 |
| E | Incorporated ECO-2610. Production effectivity S/N 213 & on. Released | 6/65 |




NOTES:

1. RESISTOR VALUES IN OHMS, 1/2W, 5% AND CAPACITOR VALUES IN MICROFARADS @ 200V, UNLESS OTHERWISE INDICATED.
2. HIGHEST REFERENCE DESIGNATORS USED:
   C4 CR5 Q8 R33 TP5
3. FACTORY SELECT TO SDC SPEC. 20011-048.
4. FACTORY ADJUST WITH OPTIMUM VALUE FROM.
5. FACTORY SELECT TO SDC SPEC. 20011-050.
6. WHEN Q3 IS SUBSTITUTE WITH A 2N3823 A F.A.T., THE FOLLOWING COMPONENTS CHANGE VALUE: R10 TO 2.5K, R11 TO 100 , R13 TO 2.5K, R14 TO 100 AND R21 TO 7.5K.
7. FACTORY SELECT TO SDC SPEC. 20011-074.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

| SCHEMATIC - SINE SHAPER ASSEMBLY 23020-1 | DRAWN R. G. | 23062 | E |
|---|---|---|---|
| | APPROVED | | |
| | DATE 15 MAY 1965 | SHEET 1 OF 1 | |

Figure 21. Circuit Card A8

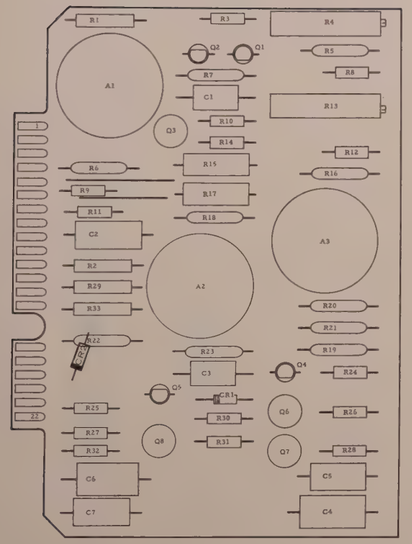
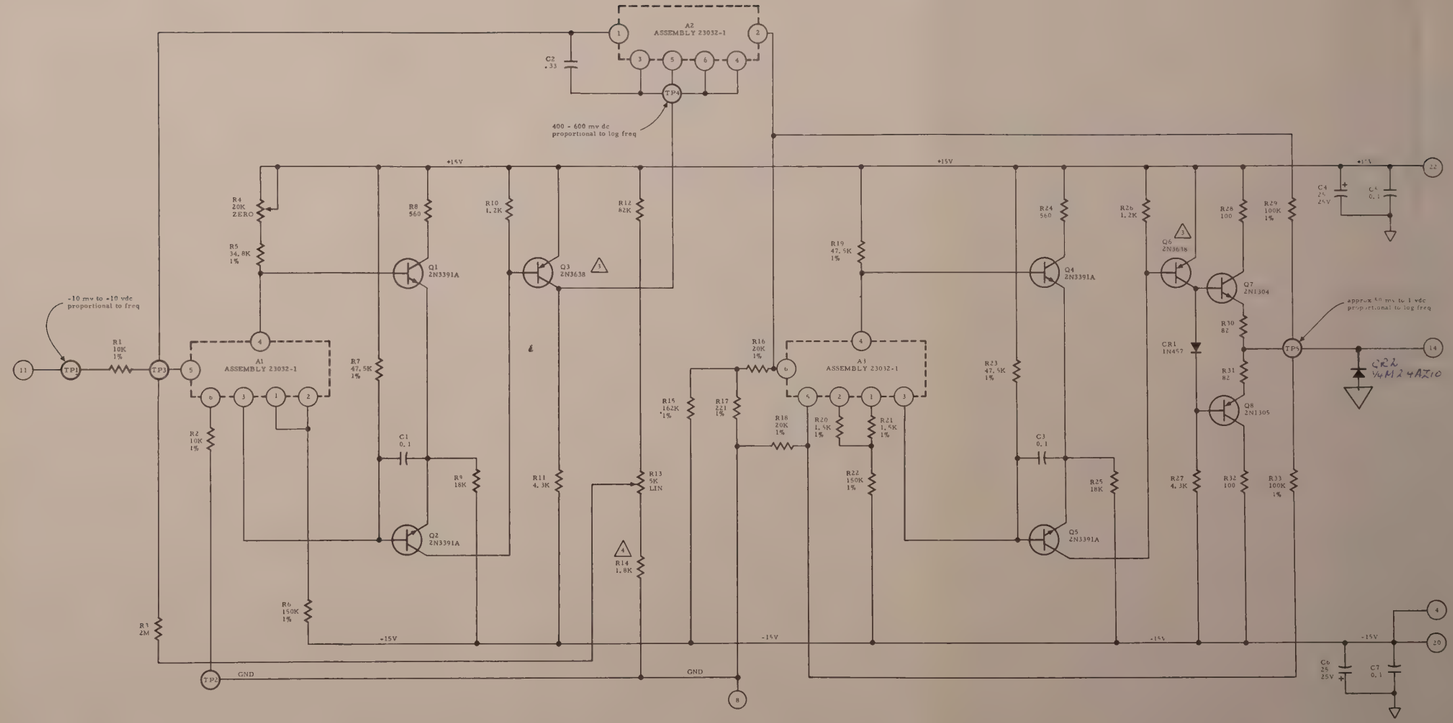



Figure 23. Component Location - Circuit Card A9
Log Converter Assembly 23038-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released for production. | 2-13- |
| B | Incorporated ECO-137. Effectivity S/N 11 and on. Miller. | 3-17- |

NOTES:

1. RESISTOR VALUES IN OHMS, @ 1/2W, 5%, AND CAPACITOR VALUES IN MICROFARADS, @ 200V, UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   A3 C7 ~~C8~~ C8 Q8 R33 TP5

1 FACTORY SELECTED.

2 FACTORY ADJUST WITH NOMINAL VALUE SHOWN.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC-
LOG CONVERTER ASSEMBLY 23038-1

DRAWN B.G.
APPROVED [illegible]
DATE 11 FEB 1965

23010 B

SHEET 1 OF 1

Figure 24. Circuit Card A9

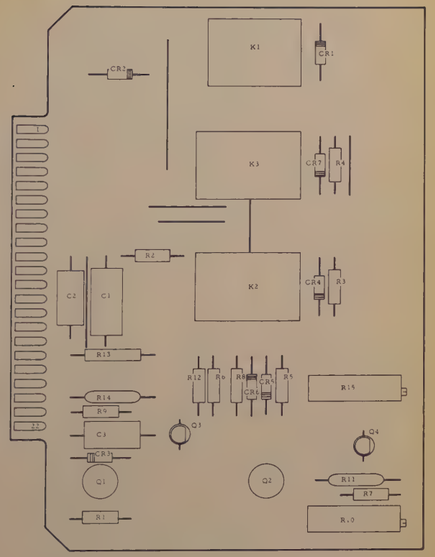
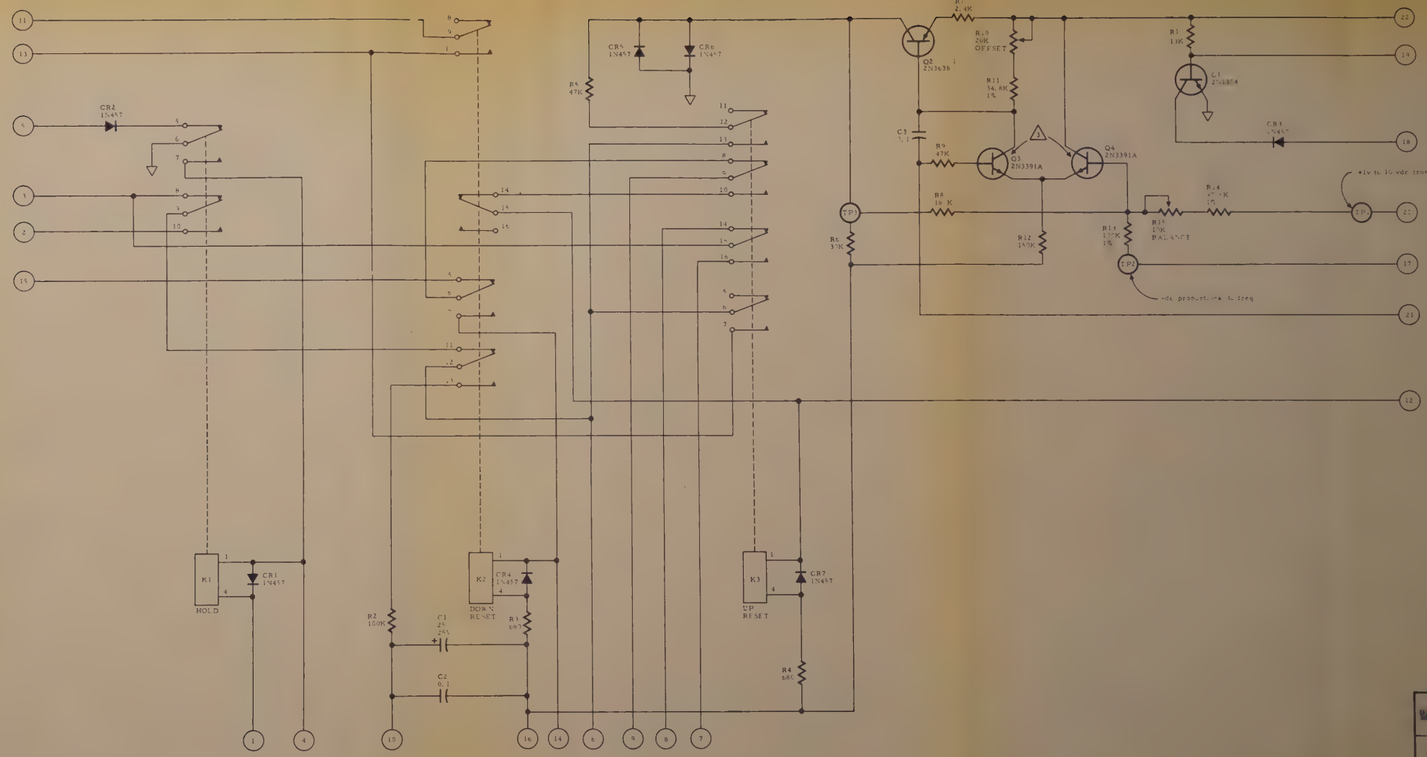



Figure 24. Component Location - Circuit Card A10
Relay Switching Assembly 23044-1




| REVISIONS | | |
|---|---|---|
| LTR | DESCRIPTION | DATE |
| A | Released to production. 115 | 4-65 |
| B | Incorporated ECO-285. Production effectivity S/N 213 & on. By per | 4-66 |

NOTES:

1. RESISTOR VALUES IN OHMS 5 5W, 5% AND CAPACITOR VALUES IN MICROFARADS @ 250V, UNLESS OTHERWISE INDICATED.
2. HIGHEST REFERENCE DESIGNATORS USED:
   C3 CR7 R3 Q4 R15 TP3
3. MATCHED PAIR PER SDC SPEC. 20013-051.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

| SCHEMATIC - RELAY SWITCHING ASSEMBLY 23044-1 | DRAWN R.C. | 23011 | B |
|---|---|---|---|
| | APPROVED [illegible] | | |
| | DATE 15 FEB 1965 | SHEET | OF |

Figure 25. Schematic - Circuit Card A1

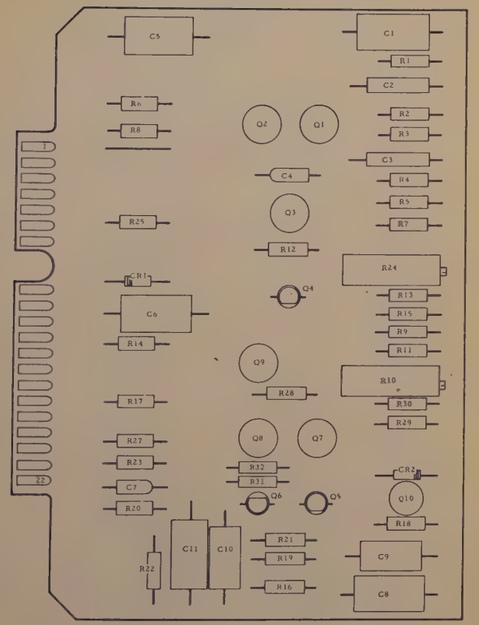
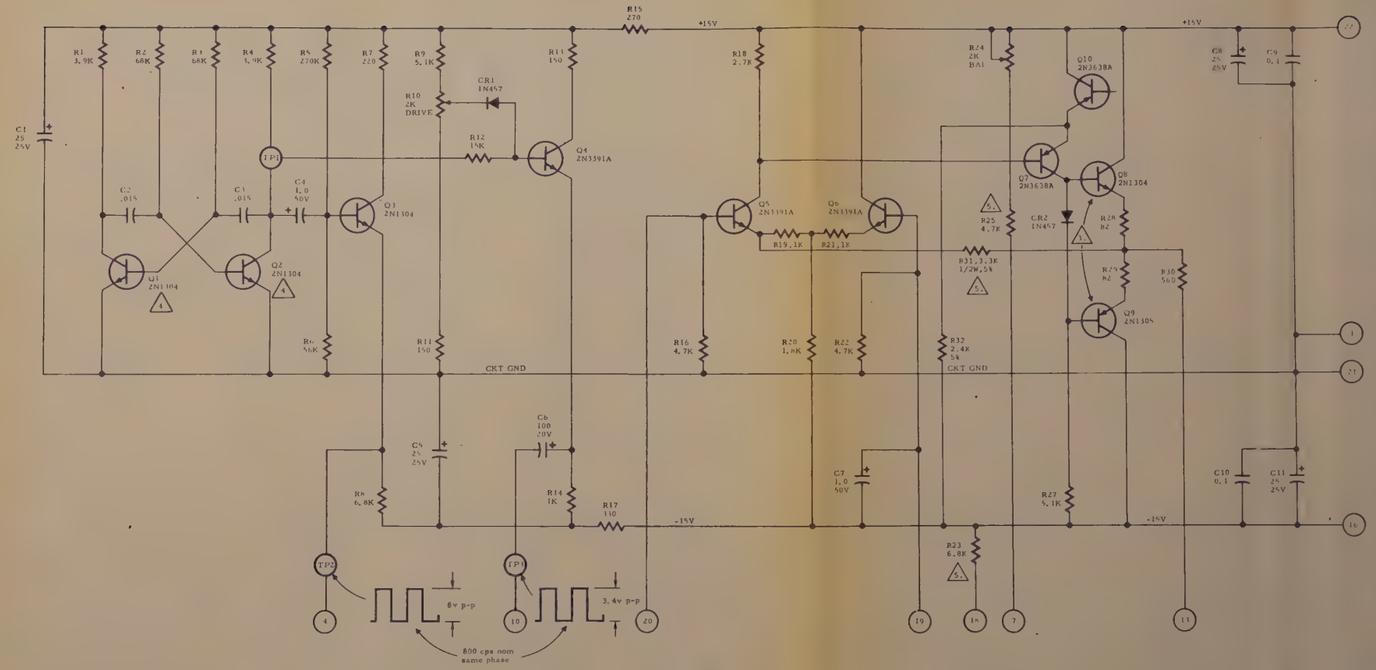


Figure 26




| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DATE | APPROVED |
| A | Released for production. | [illegible] | [illegible] |
| B | Incorporated ECO-205. Productive effectivity S/N 213 and on. B. Cole | [illegible] | [illegible] |
| C | Incorporated ECO-215. Productive effectivity S/N 214 and on. B. Cole | [illegible] | [illegible] |
| D | Incorporated ECO-218. Productive effectivity S/N 218 and on. B. Cole | [illegible] | [illegible] |
| E | Incorporated ECO 221. Productive effectivity S/N 213 and on. B. Cole | [illegible] | [illegible] |

NOTES:

1. RESISTOR VALUES IN OHMS @ 1/2W, 5% AND CAPACITANCE IN MICROFARADS @ 200V, UNLESS OTHERWISE INDICATED.
2. [illegible] REFERENCE DESIGNATORS USED C1, R2, Q10, R32, TP3.

△1 MATCHED PAIR.
△2 FACTORY SELECTED.
△3 FACTORY ADJUST WITH OPTIMUM VALUE SHOWN.

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC
CHOPPER DRIVER & OUTPUT
AMPLIFIER ASSEMBLY 21060-1

B.C.
22
15 FEB 1965

23012 E

SHEET 1 OF 1

Figure 27. Circuit Card A11

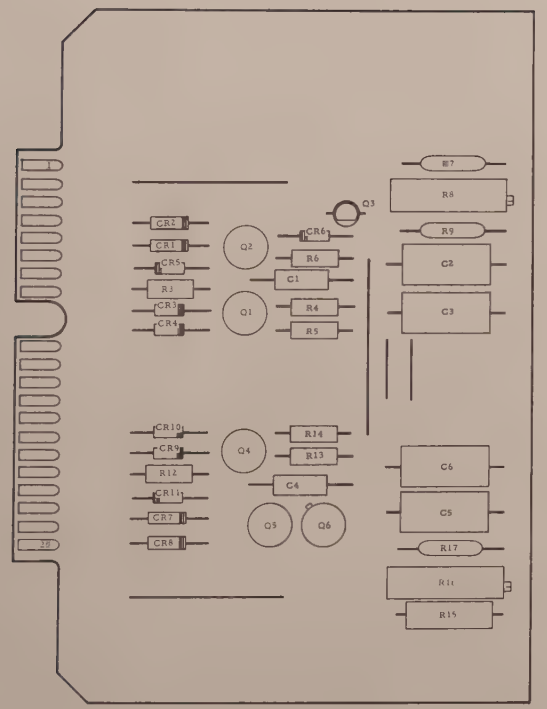
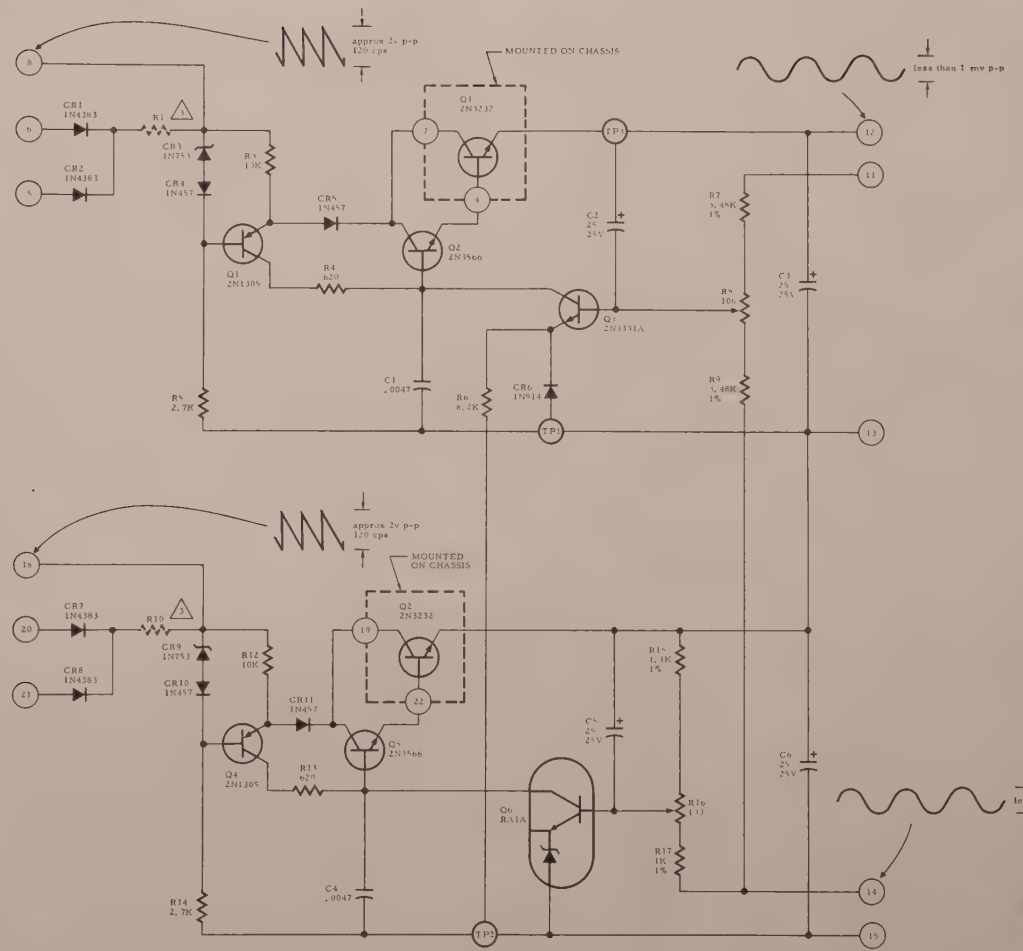



Figure 28. Component Location - Circuit Card A12
Power Supply Assembly 23036-1




| REVISIONS | | |
|---|---|---|
| CHG | DESCRIPTION | DATE |
| - | Released to production. | [illegible] |
| B | Incorporated ECO-185, Effectivity S/N 113 and [illegible] | [illegible] |
| C | Incorporated ECO-207, effectivity S/N 113 & on. B. Cote | [illegible] |

NOTES:

1. RESISTOR VALUES IN OHMS, @ 1/2W, 5%, AND CAPACITOR VALUES IN MICROFARADS, @ 200V, UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   C6 CR11 Q6 R17 TP3

△1 FACTORY ADJUST.

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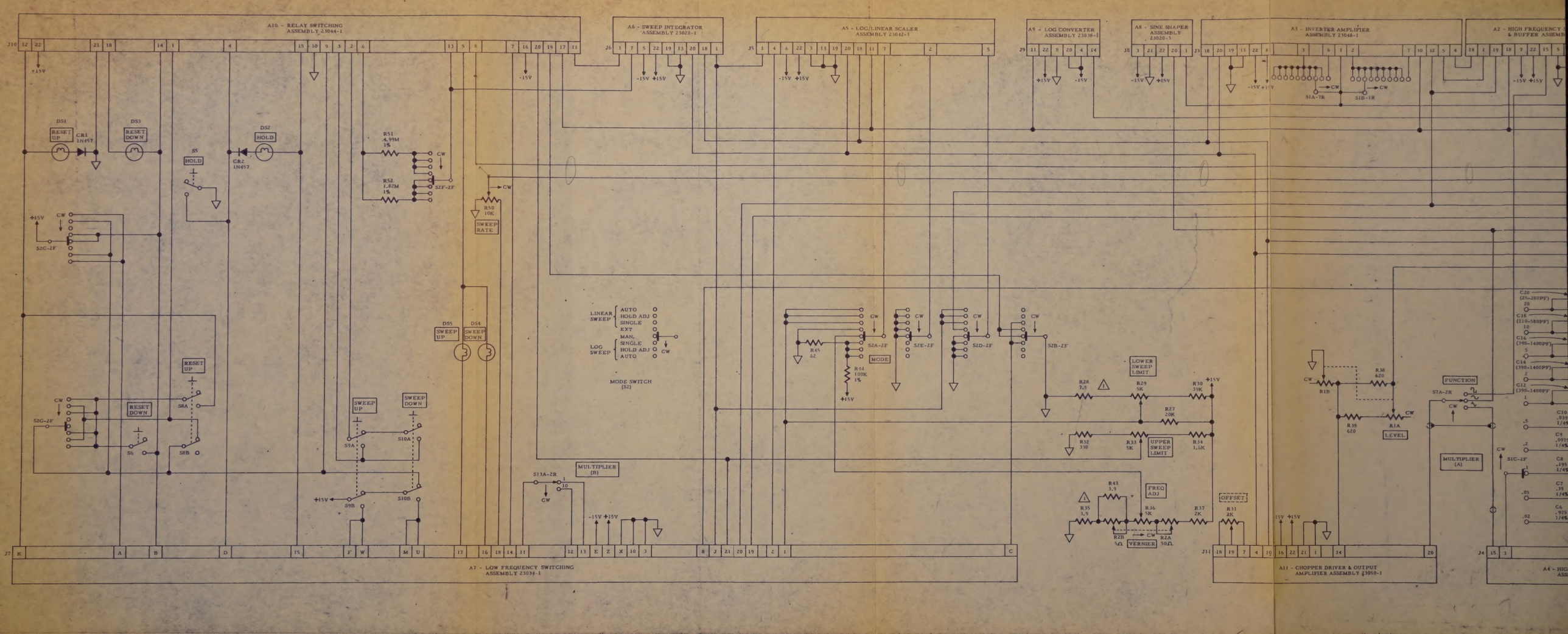
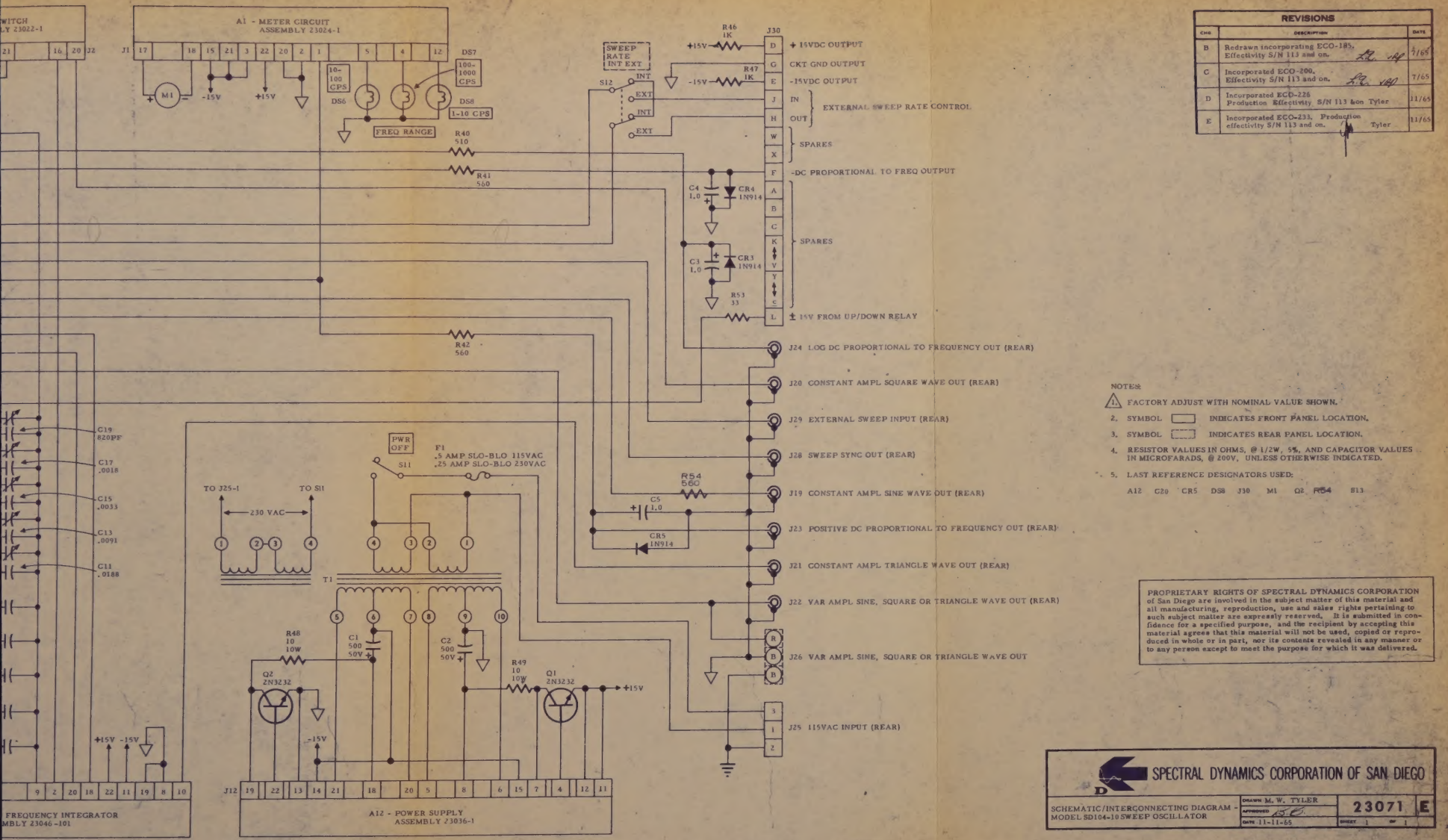
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

| | | | |
|---|---|---|---|
| SCHEMATIC - POWER SUPPLY ASSEMBLY 23036-1 | DRAWN R. G. | 23013 | C |
| | APPROVED C. | | |
| | DATE 15 FEB 1965 | SHEET 1 OF 1 | |

Figure 29. Schematic - Circuit Card A12


A10 - RELAY SWITCHING ASSEMBLY 23044-1
A6 - SWEEP INTEGRATOR ASSEMBLY 23028-1
A5 - LOG/LINEAR SCALER ASSEMBLY 23042-1
A9 - LOG CONVERTER ASSEMBLY 23038-1
A8 - SINE SHAPER ASSEMBLY 23020-3
A3 - INVERTER AMPLIFIER ASSEMBLY 23048-1
A2 - HIGH FREQUENCY & BUFFER ASSEMB
A7 - LOW FREQUENCY SWITCHING ASSEMBLY 23034-1
A11 - CHOPPER DRIVER & OUTPUT AMPLIFIER ASSEMBLY 23050-1
DS1 RESET UP
CR1 1N457
DS3 RESET DOWN
DS2 HOLD
CR2 1N457
S5 HOLD
R51 4.99M 1%
R52 1.82M 1%
S2F-2F
R50 10K
SWEEP RATE
DS5 SWEEP UP
DS4 SWEEP DOWN
S2C-2F
RESET UP
RESET DOWN
S8A
S6
S8B
SWEEP UP
SWEEP DOWN
S9A
S10A
S9B
S10B
S13A-2R
MULTIPLIER (B)
LINEAR SWEEP
AUTO
HOLD ADJ
SINGLE
EXT
LOG SWEEP
MAN.
SINGLE
HOLD ADJ
AUTO
MODE SWITCH (S2)
S2A-2F
S2E-2F
S2D-2F
S2B-2F
R45 62
R44 100K 1%
MODE
R28 7.5
R29 5K
R30 39K
R27 20K
R32 330
R33 5K
R34 1.6K
LOWER SWEEP LIMIT
UPPER SWEEP LIMIT
R43 3.9
R35 3.9
R36 5K
R37 2K
FREQ ADJ
R2B 50Ω
VERNIER
R2A 50Ω
R31 4K
OFFSET
S1A-7R
S1B-1R
R1B
R38 620
R39 620
R1A
LEVEL
FUNCTION
S7A-2R
S1C-2F
MULTIPLIER (A)
C20 (25-280PF)
C18 (110-580PF)
C16 (390-1400PF)
C14 (390-1400PF)
C12 (390-1400PF)
C10 .039 1/4%
C9 .0975 1/4%
C8 .195 1/4%
C7 .39 1/4%
C6 .975 1/4%
+15V
-15V
CW


A1 - METER CIRCUIT ASSEMBLY 23024-1
FREQ RANGE
10-100 CPS
100-1000 CPS
1-10 CPS
SWEEP RATE INT EXT
+15VDC OUTPUT
CKT GND OUTPUT
-15VDC OUTPUT
EXTERNAL SWEEP RATE CONTROL
SPARES
-DC PROPORTIONAL TO FREQ OUTPUT
SPARES
± 15V FROM UP/DOWN RELAY
J24 LOG DC PROPORTIONAL TO FREQUENCY OUT (REAR)
J20 CONSTANT AMPL SQUARE WAVE OUT (REAR)
J29 EXTERNAL SWEEP INPUT (REAR)
J28 SWEEP SYNC OUT (REAR)
J19 CONSTANT AMPL SINE WAVE OUT (REAR)
J23 POSITIVE DC PROPORTIONAL TO FREQUENCY OUT (REAR)
J21 CONSTANT AMPL TRIANGLE WAVE OUT (REAR)
J22 VAR AMPL SINE, SQUARE OR TRIANGLE WAVE OUT (REAR)
J26 VAR AMPL SINE, SQUARE OR TRIANGLE WAVE OUT
J25 115VAC INPUT (REAR)
PWR OFF
F1 .5 AMP SLO-BLO 115VAC .25 AMP SLO-BLO 230VAC
TO J25-1
TO S1
230 VAC
A12 - POWER SUPPLY ASSEMBLY 23036-1
FREQUENCY INTEGRATOR MBLY 23046-101

| REVISIONS | | | |
|---|---|---|---|
| CHG | DESCRIPTION | | DATE |
| B | Redrawn incorporating ECO-185, Effectivity S/N 113 and on. | RL 140 | 4/65 |
| C | Incorporated ECO-200, Effectivity S/N 113 and on. | RL 140 | 7/65 |
| D | Incorporated ECO-226 Production Effectivity S/N 113 &on Tyler | | 11/65 |
| E | Incorporated ECO-233, Production effectivity S/N 113 and on. Tyler | | 11/65 |

NOTES:

1. FACTORY ADJUST WITH NOMINAL VALUE SHOWN.
2. SYMBOL ▭ INDICATES FRONT PANEL LOCATION.
3. SYMBOL ▭ INDICATES REAR PANEL LOCATION.
4. RESISTOR VALUES IN OHMS, @ 1/2W, 5%, AND CAPACITOR VALUES IN MICROFARADS, @ 200V, UNLESS OTHERWISE INDICATED.
5. LAST REFERENCE DESIGNATORS USED:

A12 C20 CR5 DS8 J30 M1 Q2 R54 S13

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SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC/INTERCONNECTING DIAGRAM - MODEL SD104-10 SWEEP OSCILLATOR

DRAWN M. W. TYLER | APPROVED | DATE 11-11-65 | 23071 E | SHEET 1 OF 1

Figure 30. Interconnecting Diagram - Model SD104